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SCIENCE

17 June 1960
Vol. 131, No. 3416

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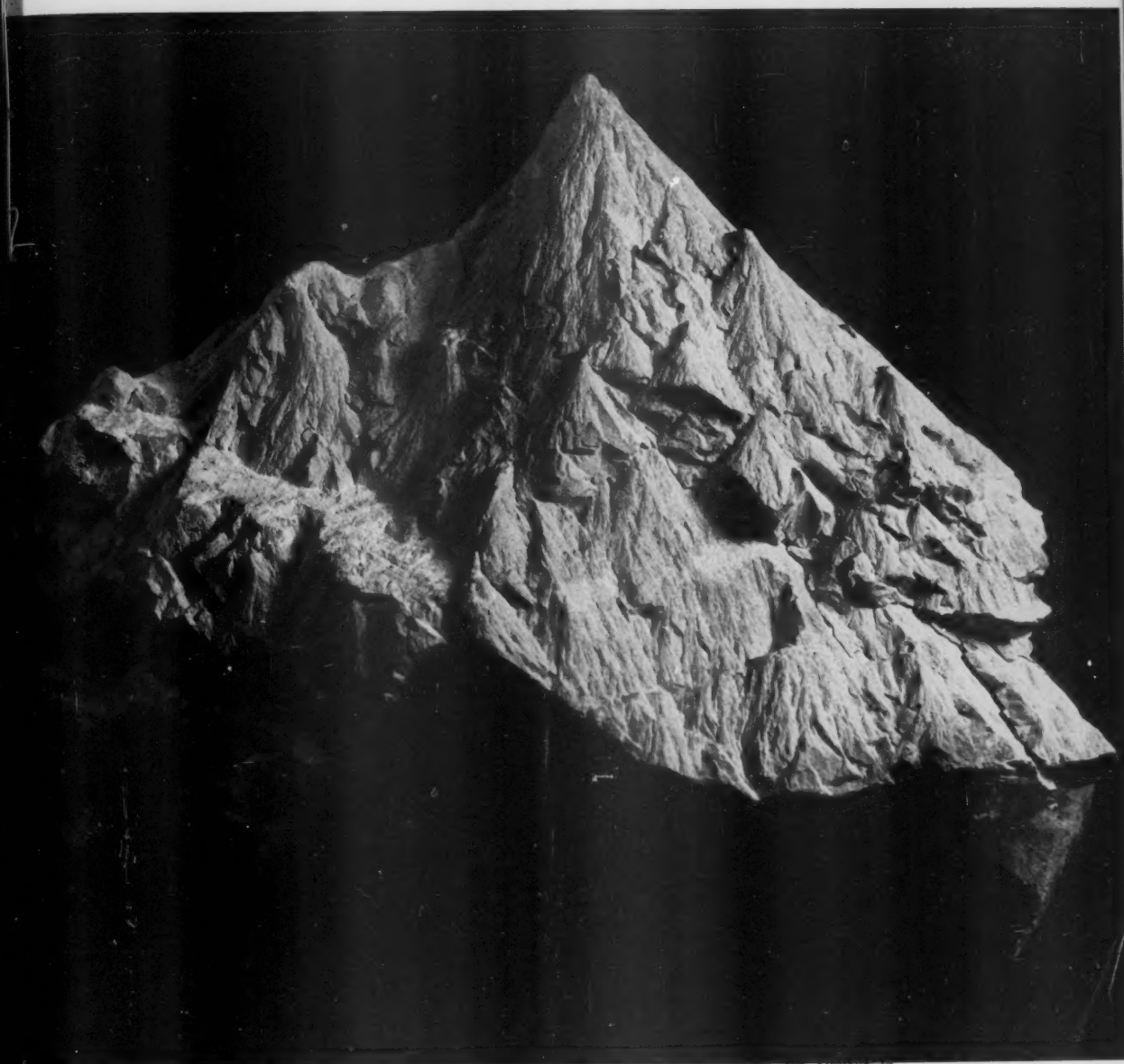

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Shatter coned Knox dolomite from the Wells Creek Basin cryptoexplosion structure in Tennessee. The coning is believed to have resulted from an intense high-velocity shock wave from a meteorite impact (about one-half natural size). See page 1781. [C. W. Wilson, Jr., Vanderbilt University]

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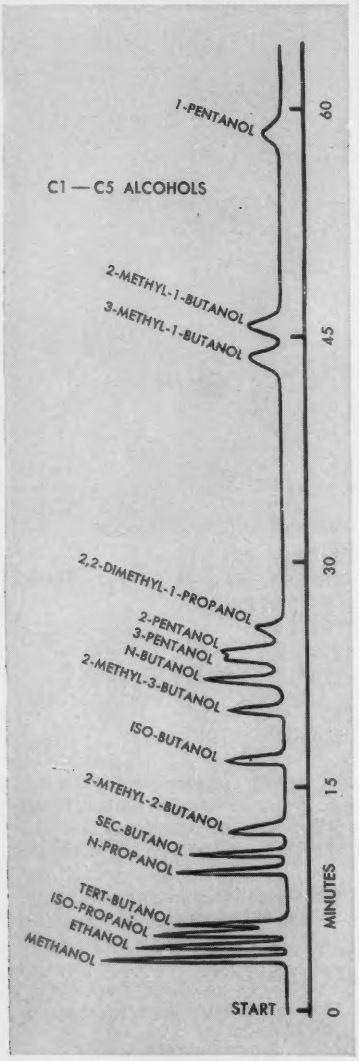

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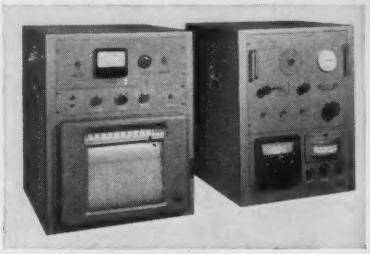

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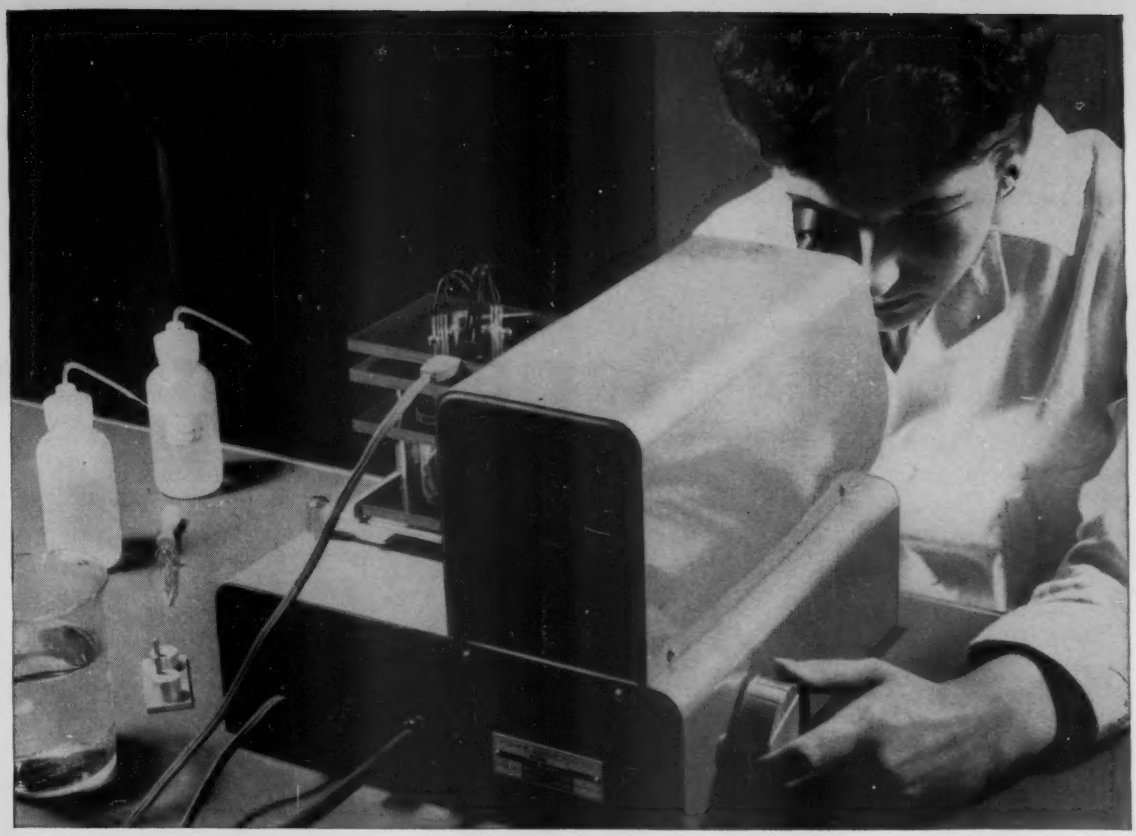

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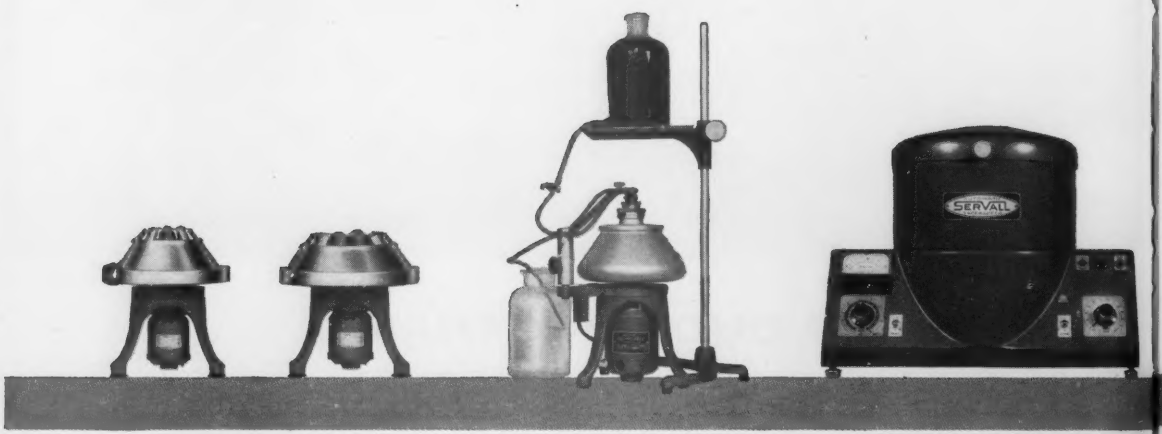

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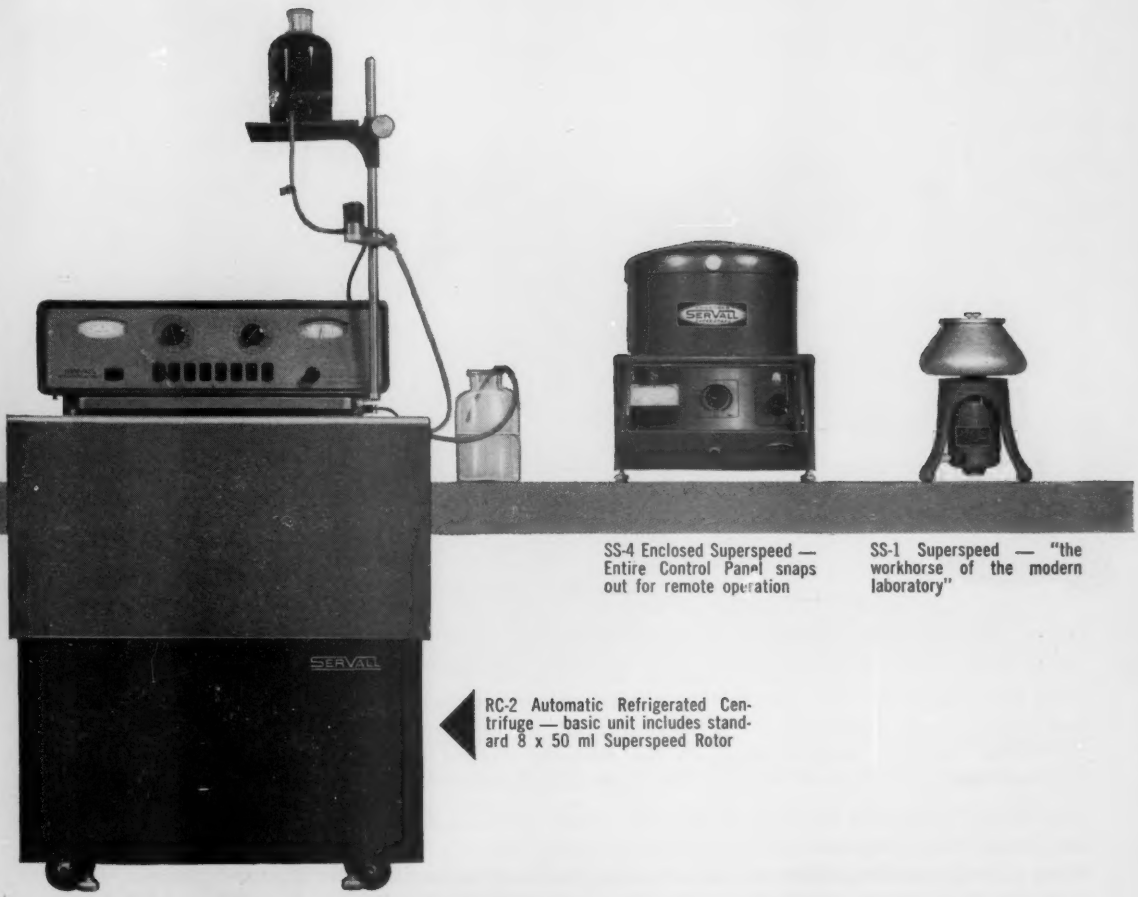

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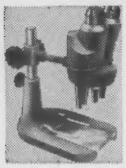

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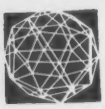

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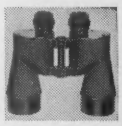

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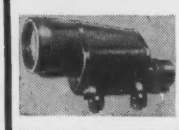

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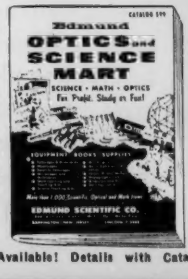

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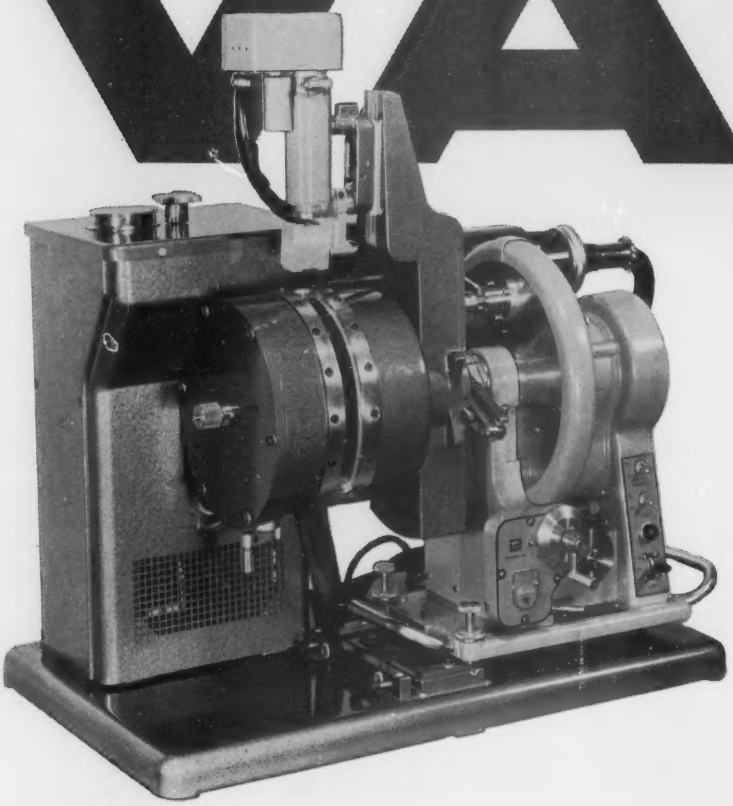

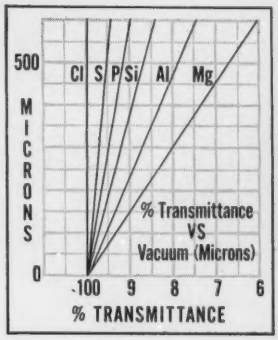

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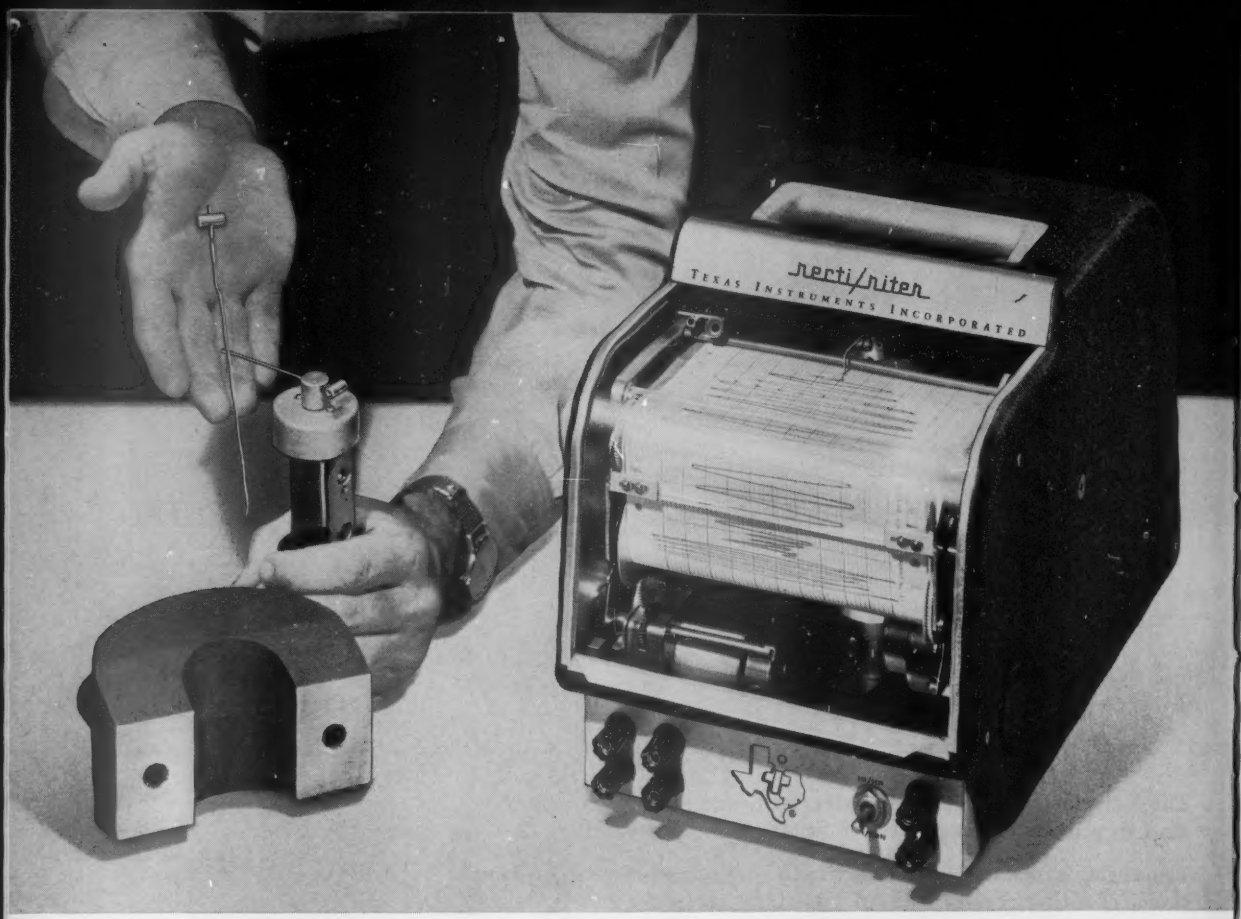

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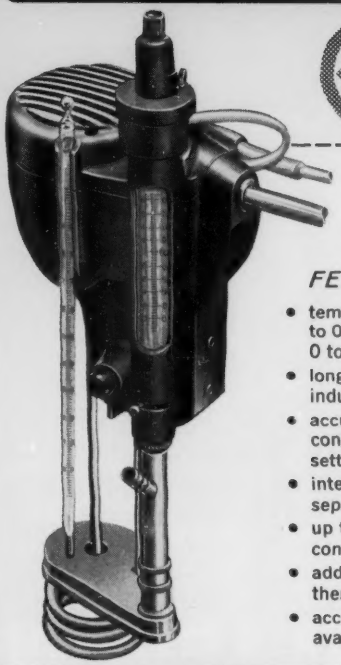

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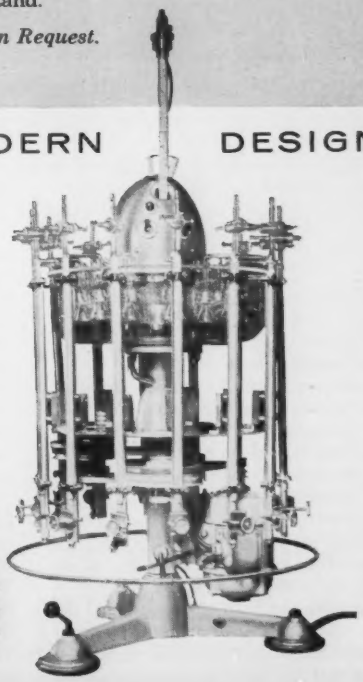

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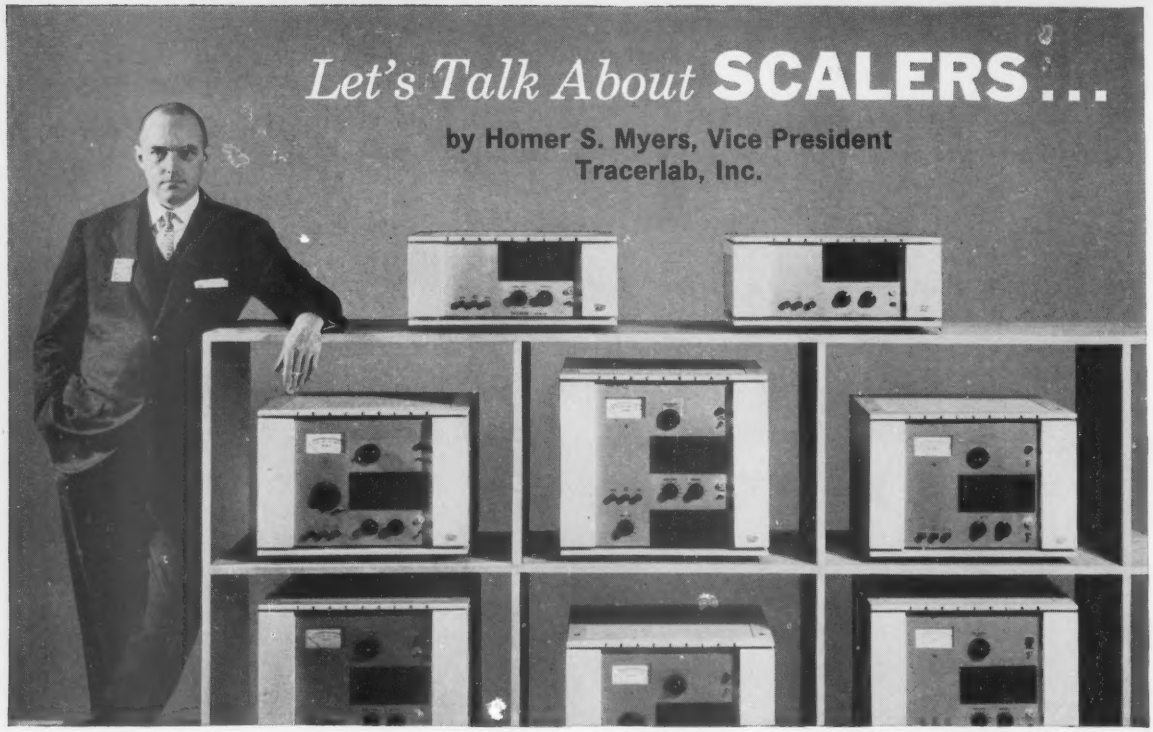

Let's Talk About SCALERS...

by Homer S. Myers, Vice President
Tracerlab, Inc.

Scalers have come a long way since Tracerlab designed and produced the first all-electronic automatic scaler back in 1946. Today several hundred types, made by more than 50 different companies, are available. So, if you are planning to buy a new one, this eight point check list will help you in making your decision. Consider:

1. The detectors it will accept.
2. Availability of preset count and preset time.
3. Resolving time.
4. Power Supply Range and Stability.
5. Ability to operate automatic systems.
6. Adaptability to future needs.
7. Reputation and experience of manufacturer.
8. Cost.

When we set out to design our new Tracermatic series of scalers, we "threw away the book," so to speak. Instead of going down the path of conventional design, where new instruments evolve by modification of existing types, we started afresh with the needs mentioned above as the principal design criteria. The result was the development of the Tracermatic family of scalers. They are, in actual fact, the only new scalers on the market today.

Designed to be compatible with every standard radiation detector, the Tracermatic scalers have the one microsecond resolving time so desirable for proportional or scintillation counting. In addition, *both* resolving time and input sensitivity can be adjusted so as to permit you to choose the optimum values for all other types of detectors. The high voltage power supplies provide a high order of stability. Output voltage varies less than 0.003% for a 1% change in input voltage. The counting circuits employ cold cathode decades for long, trouble-free life and lower operating temperature. Data displays are simple, unique and non-ambiguous *and, furthermore, no mechanical registers are used.*

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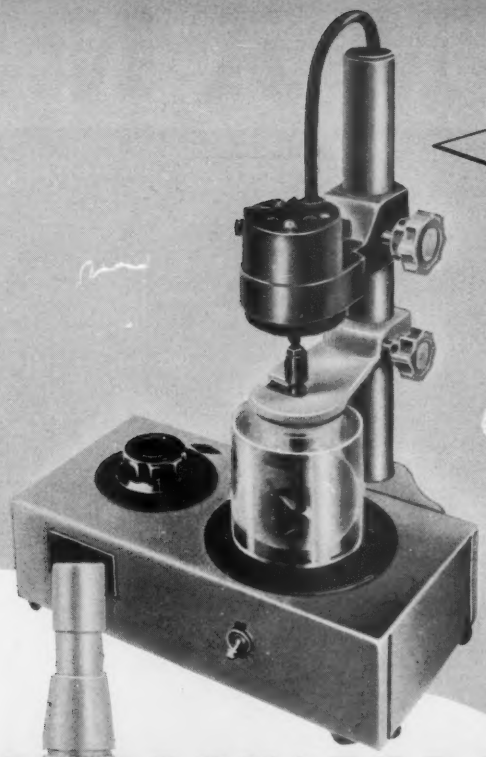

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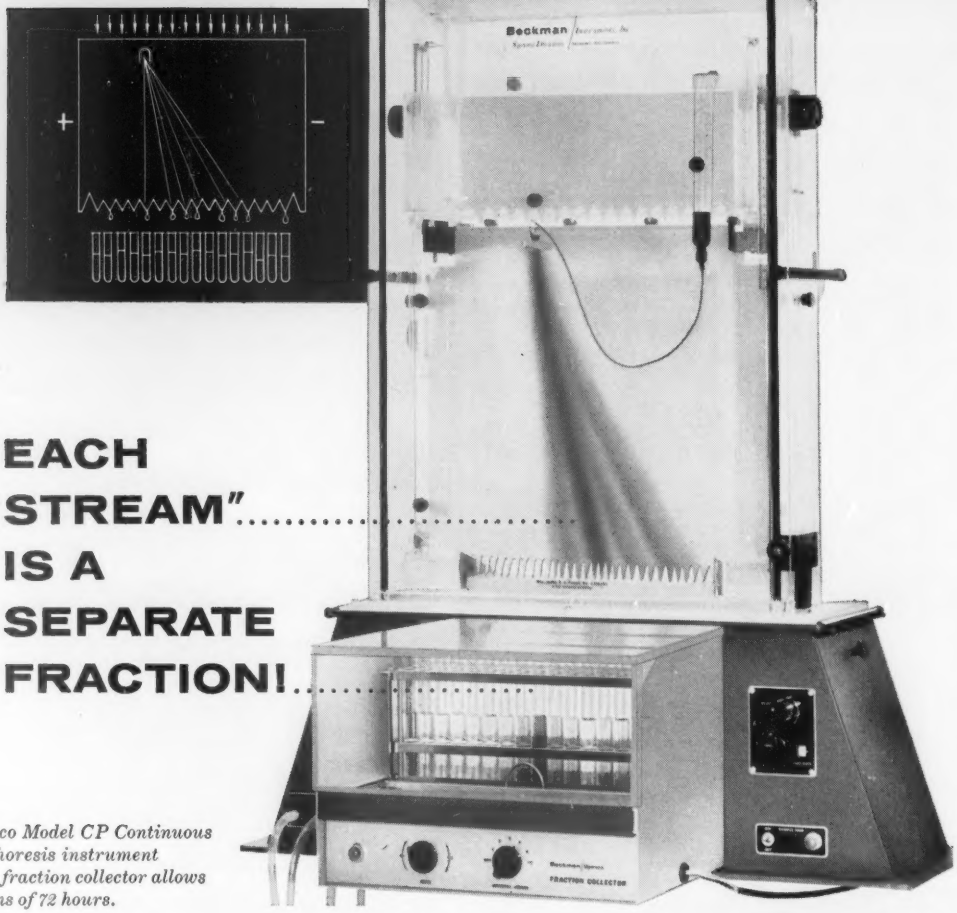

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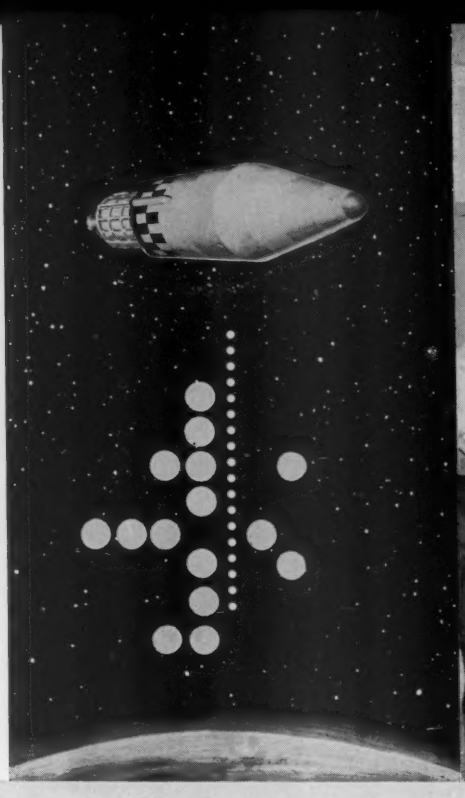

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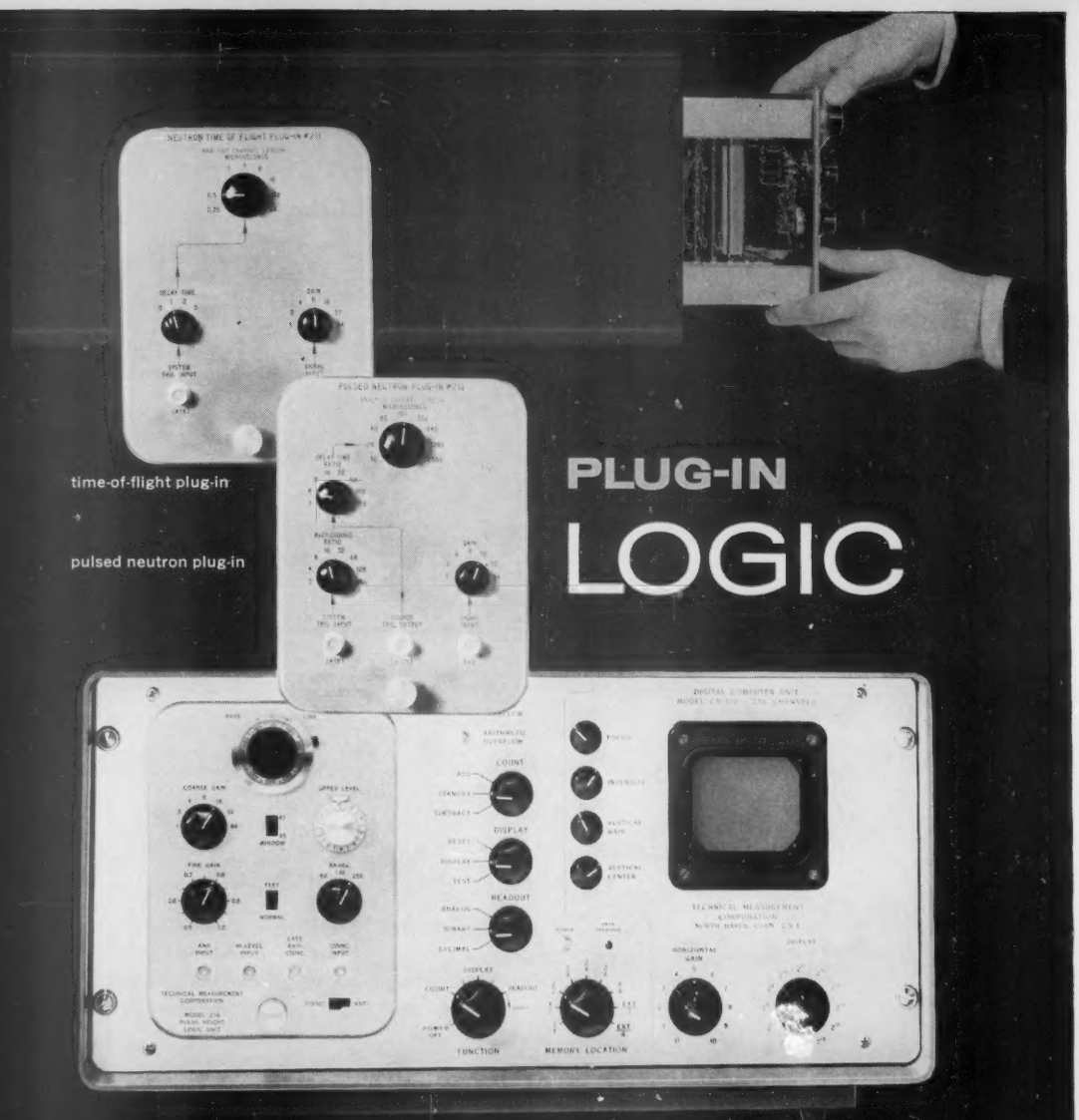

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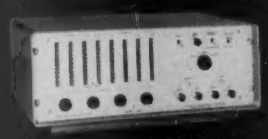

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Science Teacher Certification

State departments of education hold legal responsibility for teacher certification. In granting certificates, a state certification officer, in some instances, administers state laws and, in others, requirements set up by a state board of education or committees appointed by and advisory to the state education department. Until recently academicians have had no prominent place on these advisory committees. There is justification for the criticism that most certification requirements provide for adequate preparation in professional education but not in major specialization.

The National Council for Accreditation of Teacher Education (NCATE), affiliated with the National Commission on Accrediting, accredits teacher-education programs of colleges, requiring that the college first be accredited by the regional association, such as the North Central Association, and asks that states grant certificates to graduates of teacher-education programs of NCATE-approved colleges. Several states follow this practice but apply state standards for certificates in special areas.

As a first phase of the teacher preparation-certification study, sponsored by the National Association of State Directors of Teacher Education and Certification (NASDTEC), with the cooperation of AAAS [*Science* **130**, 1237 (1959)], four regional conferences—in Chicago, Salt Lake City, Atlanta, and New York—have been held in which preliminary recommendations of guidelines for teacher certification in science and mathematics were made. Participants included scientists, certification officers, and representatives of teachers colleges and public schools. In these conferences scientists expressed their point of view to certification officers in 47 states. The Garrett report [*Science* **131**, 1024 (8 Apr. 1960)] was highly influential in the formulation of recommendations. Certification officers demonstrated their desire to establish standards for science teacher certification much as scientists wish them to be. For example, the mathematicians recommended four courses in mathematics for the prospective elementary teacher, and certification officers supported them. It is rare, at this time, that even one course is required.

The guidelines to be prepared in the NASDTEC-AAAS study are for use by the several states in approving teacher-education programs in science and mathematics. If the study is successful, state departments of education will be advocating programs which have been developed cooperatively with scientists in the various scientific-society and curriculum projects. A college scientist may find himself to be less up to date than the certification officer in his state! At the annual meeting of NASDTEC in San Diego, 19–20 June, further consideration will be given to the regional conference recommendations. Subsequently, in the four-day San Diego conference of the National Commission on Teacher Education and Professional Standards, cosponsored by AAAS, NAS–NRC, and the American Council of Learned Societies, scientists and educators again will work together in planning improved teacher-certification programs.

Several scientific societies have studied proposals for accreditation or for recognition by them of secondary school teachers. Now some educationists are suggesting that the scientists do this. Serious study of such accreditation is called for. The NASDTEC-AAAS study recommendations will be reviewed in the 50 states in the coming year. It is essential that scientists take a very active part in these state deliberations. The leadership which scientists want from state departments of education can be obtained only if scientists are willing to give time to this important work.—JOHN R. MAYOR, *AAAS*

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17 June 1960, Volume 131, Number 3416 SCIENCE

Meteorite Impact Suggested by Shatter Cones in Rock

Three cryptoexplosion structures yield new evidence of natural hypervelocity shocks.

Robert S. Dietz

The moon's surface is peppered with with some 30,000 telescopically identifiable craters considered by most scientists to be of meteoritic origin. On the earth, two crater-forming meteorites have struck Siberia in the present century. To go back into the Quaternary, Meteor Crater, Arizona, and more than a dozen other craters in various parts of the world stand as mute evidence that the earth has not been spared from cosmic collisions (*1*). Beals (*2*) has described several impact scars or "fossil craters" in Canada of Paleozoic age and older. Under the uniformitarian principle, it would seem that bedrock-shattering meteorite impacts are a process of some geologic consequence, so that one should find meteorite impact scars or "astroblemes" (a word from Greek roots meaning "star" and "wound from a thrown object such as a javelin or stone") in ancient formations if criteria can be developed for their recognition.

Obviously, this thesis would be most convincing if one could find a large meteoritic mass resting in the middle of a chaotically jumbled area of rock. Few persons would question a direct cause-and-effect relationship. But meteorites have never been found in ancient rock, and this suggests that such fragments as are preserved from volitilization during a hypervelocity impact weather rapidly. In the absence of the meteorite, the formation of a chaotic, circular structure, extensive brecciation, and intense shattering are all suggestive of meteorite impact but are hardly definitive. Structures displaying such characteristics are known, but they are generally correctly and less esoterically explained as resulting from explosions related to volcanism or to other mechanisms.

There is, however, one aspect of a meteorite impact which should serve to differentiate an astrobleme from a structure caused by a volcanic explosion or any other terrestrial phenomenon. A giant meteorite (that is, one which is not appreciably decelerated by passage through the atmosphere) should on the average strike the earth with a velocity of about 15,000 meters per second. A principal effect of this impact is the generation of an intense and high-velocity shock wave which spreads out from the impact point, or "ground zero," and engulfs a great volume of rock before it finally decays into an elastic wave. Volcanic explosions are steam explosions involving pressures of not more than several hundred atmospheres, so it is extremely doubtful that a shock wave can be developed in rock as a part of volcanic phenomena. It appears that a lightning bolt would be a possible means of shocking rock, but such an effect would be extremely localized. Naturally occurring chemical or nuclear explosions can almost certainly be entirely ruled out. It would seem, then, that if one can produce evidence that a large volume of rock has been intensely and naturally shocked, this would constitute definitive evidence of a meteorite impact. Fortunately, at least under favorable conditions, rocks when shocked appear to fracture into a curious pattern, forming shatter cones which are preserved and may be readily identified in the field.

Shatter cones are striated cup-and-cone structures found usually in carbonate rocks, but they also have been noted in shale and chert (Figs. 1–3). Presumably, a fine-grained homogeneous rock like dolomite favors their development, but it is not an absolute requirement. The striated surfaces radiate from small parasitic half-cones on the face of a master cone—a pattern which serves to differentiate these striations from the parallel grooving of slickensided fault planes. The apical angles of the cones are from 75 to nearly 90 degrees. The size of the cone apparently depends upon the thickness of the bed which yields as a unit. Some cones as small as 1 centimeter in height have been collected at the Crooked Creek (Missouri) deformation, while at Kentland (Indiana) cones as long as 2 meters have been seen in limestone and cones longer than 12 meters in shale. This coning is apparently a type of mechanical failure under percussion which causes a stratum to become thinner and slightly more elongate by normal faulting—that is, by downward slipping of the cup relative to the cone.

A pertinent question is: Do shatter cones unquestionably require a shock wave for their formation? This cannot be categorically answered, but it is clear that they are quite distinct and different from two geological structures which they vaguely resemble and with which they might be confused—namely, cone-

The author is affiliated with the U.S. Navy Electronics Laboratory, San Diego, Calif.

in-cone structures and slickensides. In the United States, shatter cones have been found only very near the center of some of the structures identified in the 1940 edition of the *Structural Map of the United States* as cryptovolcanic structures—that is, deformations formed by a hidden explosion somehow considered to be related to volcanism although no direct evidence of this volcanism, such as volcanic rocks or hydrothermal alteration, is found. Thus, they are uniquely present in structures considered to have been caused by a natural explosion. I prefer the term *cryptoexplosion structures* to *cryptovolcanic structures*, so as not to exclude the possibility of an extraterrestrial origin.

Shatter cones have never been reported from normal geological situations, so it would seem that they are not formed by tectonic stresses or by simple static loading. Nor have they been reported from rocks known to have been engulfed by volcanic explosions. So far as artificial detonations are concerned, low-velocity heaving explosives such as commercial dynamite (detonation wave velocity, about 5000 m/sec), which are almost exclusively used for quarrying and similar operations, commonly produce rude cones, but these lack the surface markings of shatter cones. On the other hand, military explosives of high detonation velocity and high *brisance* or shattering effect, like RDX (detonation wave velocity, 8000 m/sec), form cones with surface markings closely resembling those of shatter cones but not so perfectly formed as shatter cones. By extrapolation, it would seem that even greater *brisance* than that of RDX is needed to produce good shatter cones. Since the mean geocentric velocity of meteorites is about 15,000 meters per second, it is to be expected that extremely intense shattering will result for large bolides not appreciably cushioned by the atmosphere. One may conclude that rare natural conditions are required to produce shatter cones but that such conditions could be provided by a large meteorite impact. (*Note added in proof*: A visit to the site of an underground nuclear bomb test revealed portions of large shatter cones in volcanic tuff like those in Richmond shale at Kentland Quarry. Nearby, indurated clay beds beneath the sites of large test explosions of TNT displayed tent-shaped features very similar to shatter cones. The tent shape presumably resulted from a cylindrically spreading shock wave produced by the cylindrical high-explosive charge.)

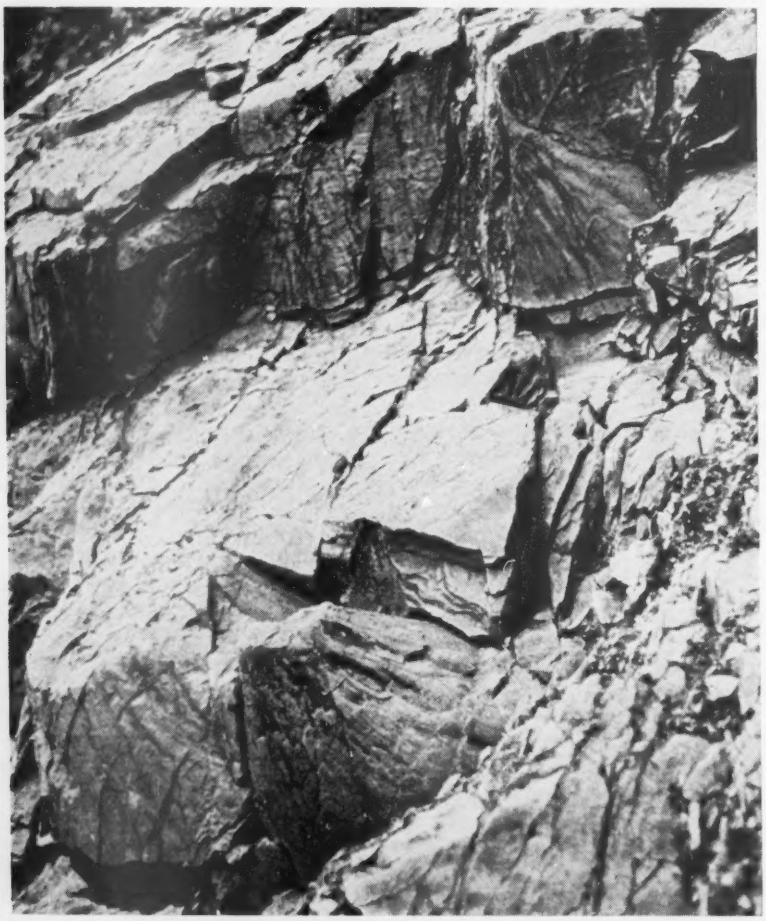

Fig. 1. Shatter cones in Ordovician limestone at Kentland quarry, Indiana. Cones are nearly 1 meter in length and are oriented upward. Such cones are believed to be indicative of a natural shock of high velocity which could only be generated by a meteorite impact.

Recently, I prepared a paper (*3*) describing the four localities in the world where shatter cones had been discovered—Steinheim Basin, Germany; Wells Creek Basin, Tennessee; Kentland, Indiana; and Crooked Creek, Maryland. In that paper I also cited five additional similar structures in the United States. An invitation from G. Kuiper to study the moon's surface at the MacDonald Observatory afforded me an opportunity to visit one of these structures, at nearby Sierra Madera, Texas. Shatter cones were found to be excellently developed there. With this new stimulus, I quickly visited the four other structures—Serpent Mound, Ohio; Flynn Creek, Tennessee; Jeptha Knob, Kentucky; and Howell, Tennessee. Shatter cones were discovered at the first two sites named. Rock outcrops at the Howell structure are too poorly developed to permit any intensive search there. The search at Jeptha Knob was not exhaustive, but it seemed that this structure is probably not of the same type as the others.

Sierra Madera Structure

This circular (2-mile diameter) and intensely deranged structure lies 20 miles south of Fort Stockton, Texas, in the vicinity of the Glass Mountains. The geology of this uplift has been described by King (*4*) as an intensely

deformed and brecciated area of Permian strata with a central domal uplift surrounded by a ring syncline and possibly a ring fold. Pointing out the damped wave form of this structure, Boon and Albritton (*5*) included it in their list of structures possibly created by meteorite impact. However, Shoemaker (*6*) doubts that detailed mapping will support the conclusion that this is an example of central domal uplift and ring fold form; instead, he believes that the central dome is a mass of megabreccia. Wilson (*7*) reports that two wells drilled to 7000 and 12,000 feet, respectively, revealed no evidence that volcanism played any part in the formation of this structure. A core at 8000 feet revealed only moderate dips, and this suggests that the structure may tend to die out with depth.

A field trip to Sierra Madera in October 1959 revealed the frequent occurrence of shatter cones; thus, this became the fifth locality in the world in which they are known. Although cones in the area are distinctive and numerous, shatter-coning of rock there, as elsewhere, is a subtle characteristic so it is not surprising that others have not previously reported them. The shattering is more extensive at Sierra Madera than at any other locality where shatter cones have been found, although the rocks are not as intensively shattered there as at Wells Creek Basin. The first fragment was discovered in the float of a dry creek on the flank of the structure. Even cone fragments no larger than one's thumb are so distinctive that they are immediately identifiable. During two days of search literally thousands of shatter cones and cone fragments were seen near the center of the structure. Usually these were developed in thin beds lying between more massive strata, but sometimes they were present in the thicker beds as well.

Serpent Mound Structure

I visited this highly deranged structure in November 1959 to search for shatter cones. I examined several peripheral areas, including a quarry which revealed a large mass of what may be explosion breccia, but I found no shatter cones. I then visited the absolute center of this circular deformation and began an intensive search for shatter cones. No outcrops are exposed, so it was necessary to resort to breaking open such residual boulders as could be found. Eventually a boulder was split which clearly revealed these cones. Subsequently, in a period of two days, shatter cones were found in about 20 boulders, or in a ratio of about one in each 25 boulders split open. Boulders containing shatter cones were readily split asunder, while others were difficult to break open. Since cones, as always, were found only in the immediate vicinity of the structure's center, it would seem that the shattering associated with any such cryptoexplosion structure is concentrated near ground zero, although the rocks are heaved up over a much larger area.

Serpent Mound was first mapped and described in 1920 by Bucher (*8*), who considered it to be cryptovolcanic and similar to the Steinheim Basin structure in Germany; however, he was not aware of the presence of shatter cones like those already known then at Steinheim, the type locality for them.

Flynn Creek Structure

This deformation was originally described by Wilson and Born (*9*), who considered that it was created by a cryptovolcanic explosion. Wilson (*10*) now has revised this opinion, attributing the origin of the structure to a meteorite impact. With C. W. Wilson and R. Stearns, I visited the deformation in November 1959. We discovered some shatter cones in a thin bed along a new road cut not far from the structure's center; thus, this became the seventh known locality for shatter cones. Although these shatter cones are poor examples, the identification is unquestionable. Probably a more detailed search would reveal more distinctive beds.

Meteor Crater

The present theory would, of course, be more convincing if shatter cones were found at well-established, modern meteor craters. With this in mind, I examined the rocks at Meteor Crater, Arizona; the search was by no means exhaustive, but no shatter cones were found. If cones are in fact completely absent from the formations exposed at Meteor Crater, this may be due to one of several causes. For example, the rocks immediately beneath ground zero are now covered with lake beds. Another possible explanation lies in the considerable deceleration by the atmosphere of comparatively small crater-forming meteorites. The 300-ton Sikhote Alin meteorite presumably entered the atmosphere at a velocity of about 15,000 meters per second, but it struck

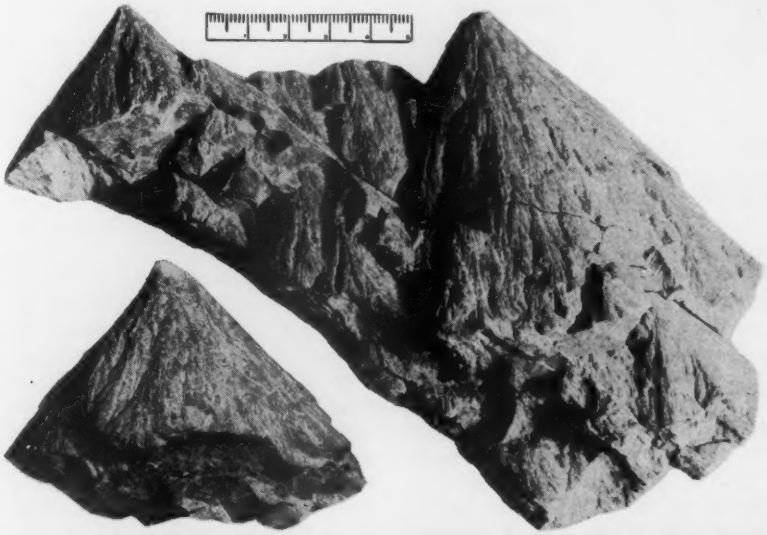

Fig. 2. A group of shatter cones in Knoxville dolomite from the Wells Creek Basin cryptoexplosion structure in Tennessee. The characteristic parasitic coning on the master cone and the common orientation of many interlocking cones is clearly displayed. A single cone is shown below. Scale in centimeters.

Fig. 3. A collection of shatter cones from the Permian dolomite at the Sierra Madera cryptoexplosion structure in Texas.

the earth at only 500 meters per second —a 97 percent deceleration (*11*). Although much larger, the Meteor Crater bolide, estimated by Shoemaker (*12*) to have weighed 63,000 tons and to have measured 80 feet in diameter, may have been somewhat slowed down. If shock-wave velocities of, say, at least 10,000 meters per second are needed to produce shatter cones, as is suggested by extrapolating from tests with commercial dynamite through high-shattering military explosives, then shatter cones may not have formed at Meteor Crater. Only crater-forming meteorites of somewhat larger size than the Meteor Crater bolide or with a greater geocentric velocity would produce them. However, Shoemaker believes that the impact velocity at Meteor Crater was in excess of 10,000 meters per second.

Orientation of Shatter Cones

The orientation of shatter cones is useful for establishing the impact direction. In most cases the cones point opposite to the direction of shock-wave propagation—in other words, toward the locus of pulse source. It is to be expected that the simple spherical spread of the shock wave from its source will be complicated by reflections from interfaces and by other factors, so that shatter-cone orientation will be somewhat complex.

A visit to Kentland quarry, where there is a great amount of new excavation, confirmed my previous opinion (*13*) that the cones there show a preferred orientation. An examination of several hundred cones exposed in the quarry face shows that roughly 95 percent are oriented normal to the strata and point upward. The remainder of the cones are inverted, as though by a directly reflected wave. The inverted cones are rather difficult to find, since the rock tends to split away more easily around the upright cones where the fracturing is stronger. The term *upward* is used here relative to the presumed original flat position of the beds, since the beds would presumably have been invaded by the shock immediately prior to upheaval.

One rare inverted cone was also found at the Wells Creek Basin structure, although nearly all of the cones there point in the upward direction. At Sierra Madera the cones appear, in general, to point upward, but more work needs to be done to determine which beds, if any, are overturned. At Flynn Creek the orientation is also upward. At the Steinheim Basin structure, an unusual specimen was found showing cones pointing in three directions. The general upward orientation of the cones at all localities where orientation can be determined suggest impact percussion rather than volcanic forces, which would come from below.

Conclusions

Shatter cones probably are a specific criterion for identifying the root structures of large fossil meteorite impacts, so geologists have a useful "index fossil" for astroblemes. These provide a site for the study of effects of hypervelocity impacts which have released energies equivalent to several H-bombs. Astroblemes may also be useful for understanding the origin of lunar craters, which probably are similarly formed. At the very least, all deformations which contain shatter cones must be assigned a single mode of origin (*14*).

Note added in proof: An eight[h] world locality for shatter cones unquestionably is the rim of the crater occupied by Lake Bosumtwi, Ashanti, Ghana. This crater has been widely reported as of probable meteoritic origin. H. Rohleder (*15*) described and showed percussion cones, termed by him *Drucksuturen* or *Druckfiguren*, along with reconstituted pulverized rock. He states that these cones are apparently of the same origin as the *Strahlenkalk* (the type examples of shatter cones) at the Steinheim Basin structure. He apparently does not use this last term, since the shatter cones are in Precambrian quartzite rather than in limestone.

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14. I wish to acknowledge the assistance of the following: E. M. Shoemaker (U.S. Geological Survey) for many useful ideas, scientific guidance, and assistance on field trips to Sierra Madera, Meteor Crater, Kentland, and Serpent Mound; of Arnold Mason and Robert Hackman (U.S. Geological Survey) and Charles King (Sul Ross College) for assistance on field trips to Sierra Madera; of Karl Hoover (Ohio Geological Survey) for field guidance at Serpent Mound; of Raymond Gutschick (Notre Dame) for guidance at Kentland; of C. W. Wilson, Jr. (Vanderbilt) and Richard Stearns (Tennessee Division of Geology) for field guidance at Wells Creek Basin, Howell, and Flynn Creek; and, finally, of John Beagles (U.S. Navy Electronics Laboratory) for help in experimentation with explosives.

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The Tercentenary of the Royal Society

The oldest learned society, through meetings, grants, and publications, encourages scientific inquiry.

D. C. Martin

"I know not whether any of your learned body have attain'd the ancient boasted Art of *multiplying* Gold; but you have certainly found the Art of making it infinitely *more valuable*.

"You may easily bestow your Favours on Persons of more Merit: but on none who can have a higher Sense of the Honour, or a more perfect Respect for your Society and Esteem of its excellent Institution."

Thus wrote Benjamin Franklin from Philadelphia on 29 May 1754 to the president and council of the Royal Society, who had just awarded him the Copley medal, the society's highest medal award. Three years later Franklin was, "on Account of his Curious Experiments and Observations on Electricity," elected a fellow of the society. He later served as a member of the council and took an active part in the work of some of the society's committees.

The Royal Society was already nearly 100 years old when this tribute from so versatile a genius was made. That the American Philosophical Society's objects were so close to those of the Royal Society shows clearly how well acquainted Franklin was with the work of the London Society. The first contacts with the North American continent, however, go back to the very beginnings of the society, for numbered among the original fellows was John Winthrop, governor of Connecticut (1660–1676), who was well acquainted with Robert Boyle, John Wilkins, and Henry Oldenburg and other founder fellows of the Royal Society; after 1660 he corresponded with the new society, sending specimens for its collections. In 1741 Cromwell Mortimer, secretary of the society, in a dedication of the 40th volume of the *Philosophical Transactions* to John Winthrop, fellow of the Royal Society, a grandson of the governor, wrote that, but for the ending of the civil war, Boyle and others "out of esteem for the most excellent and valuable Governor, John Winthrop the younger, would have retired to this new born colony and there established that Society for promoting Natural Knowledge which these gentlemen had formed, as it were, in embryo among themselves, but which afterwards receiving the Protection of King Charles II obtained the style Royal, and hath since done so much honour to the British Nations as to be imitated by the several European Princes who desired to be esteemed the Patrons of Learning."

The Foundation

The decision to found "a Colledge for the promoting of Physico-Mathematicall Experimental learning" was taken on 28 November 1660 by a group of natural philosophers meeting in Gresham College in the City of London, after a lecture given by Christopher Wren. The idea had been in the air for some time, but it is this formal step, which is the true beginning of the corporation now known as the Royal Society of London for the Improvement of Natural Knowledge, that is being commemorated this year in London. Within a week "Sir Robert Moray brought in word from the Court that the King had been acquainted with the designe of this Meeting. And he did well approve of it and would be ready to give encouragement to it." The royal charter incorporating the society was granted on 15 July 1662.

The society still has several direct links with those early days, including the journal book recording the meetings begun in November 1660 and also two magnificent gifts from the King, a mace and the Charter or Signature Book in which King Charles II inscribed his name, followed by the word *founder*. Queen Elizabeth II is the 13th monarch to continue the tradition of royal patronage, and she has graciously consented to open the tercentenary celebrations this year. At the opening ceremony she will be accompanied by H. R. H. Prince Philip. King Gustav VI of Sweden, who was elected a fellow in 1959, will also be present and will be invited to inscribe his name in the Signature Book and to be admitted formally to the society by the president, who will use the three-century-old formula, "I do, by the authority and in the name of the Royal Society of London for Improving Natural Knowledge, admit you a Fellow thereof." These self-same words of formal admission have been used to admit all those fellows whose names are written in this great book. Here we find not only Isaac Newton, Robert Hooke, Robert Boyle, Edmund Halley, Joseph Banks, James Cook, Charles Darwin, and Michael Faraday but also Huygens, Franklin, Mendeleev, Planck, and numerous other distinguished scientists from all over the world.

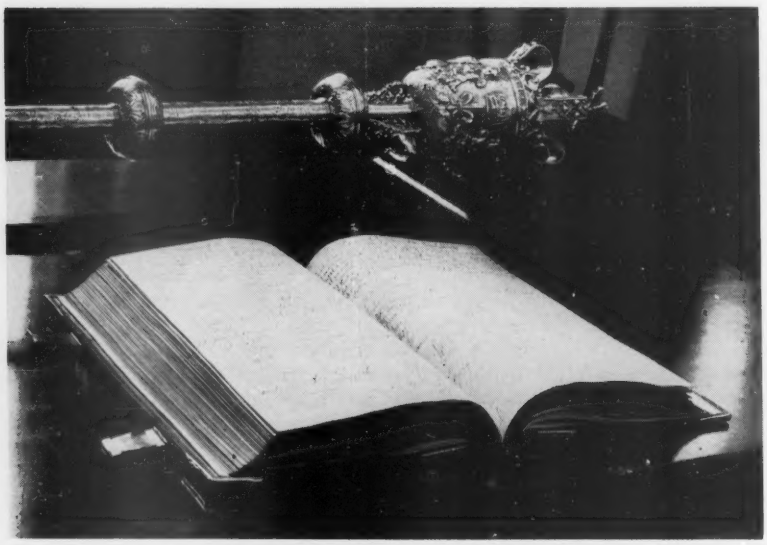
The First Century

The mid-17th century founders of the Royal Society were men of outstanding merit and foresight, enthusiastically dedicated to the new philosophy of experiment. They believed that the study of nature could only be successfully prosecuted and advanced by means of experimental research and so gave it the highest place as *Domina omnium scientarium*. Within 100 years, fellows had achieved much. Boyle's discoveries had yielded fundamental laws; his assistant Robert Hooke, who had been the first of the society's curators of experiments for the weekly meetings, had, among many acts of experimental genius, constructed his compound microscope and made many new discoveries with it which he described in *Micrographia*, issued in 1665 under the imprimatur of the society. In 1671 Isaac Newton had presented the society with his reflecting telescope, still one of its treasured possessions, and in addi-

The author is assistant secretary of the Royal Society, London.

Portrait of Sir Isaac Newton.

tion he had been persuaded to publish his fundamental work on the nature of light and the gravitational theory of planetary motion. The society had published in 1687 Newton's great book, the *Principia*, described by Laplace as "pre-eminent above any other production of human genius." From 1703 to 1727 Newton had been president and had added even greater luster and renown to the society. Hans Sloane, a great natural historian who had made valuable collections that were later to become the basis for the British Museum collections, had succeeded Newton in the presidential office. Huygens, Malpighi, Leibnitz, and Leeuwenhoek had all been elected fellows and had made outstanding contributions toward the creation of the new scientific age. Henry Oldenburg had begun, in 1675, production of the *Philosophical Transactions*, using the medium of the press to communicate the new knowledge, and so established the world's senior scientific journal. Edmund Halley had made great contributions to astronomy and had undertaken voyages to make the first magnetic chart of the oceans. This, then, was the institution which had earned the "perfect respect" of Benjamin Franklin.



Two of the Royal Society's greatest treasures—the silver gilt mace presented by Charles II in 1663 and the Charter Book, prepared soon after the incorporation of the society in 1662. The Charter Book contains signatures of most of the society's fellows, from the beginning to the present day. The mace, symbol of authority, is still placed in front of the president at every meeting of the council or of the society.

Scientific Expeditions

Shortly after Franklin's election the society, following Halley's example, sponsored a number of scientific expeditions, notably those of Captain James Cook. Cook began his last voyage in July 1776 in the *Resolution* and the *Endeavour*, to explore the islands and coasts of the Pacific. He was at sea when the War of Independence began, and Franklin, then American envoy in Paris, issued an instruction to all American captains and commanders of ships to spare and aid "that most celebrated Navigator and Discoverer, Captain Cook," describing his mission as "an Undertaking truly laudable in itself, as the Increase of Geographical Knowledge facilitates the communication between distant Nations, in the Exchange of useful Products and Manufactures, and the Extension of Arts whereby the common Enjoyments of human life are multiply'd and Science of other kinds increased to the benefit of Mankind in general."

Beside me as I sit in my room at the Royal Society there is an interesting link with Captain Cook in the form of a clock made by John Shelton to the order of the society in 1760. It is ticking out the last hours of its second century and keeps perfect time. Shelton's clock was sent to St. Helena in 1761 to measure, by the period of oscillation of a pendulum of fixed length, the force of gravity at St. Helena for comparison with measurements made in Greenwich. On its return journey it was used for gravity measurements at Cape Town. In 1763 John Harrison's marine chronometer was tested by it, and in 1766 it was used in North America by Charles Mason and Jeremiah Dixon in demarcating the line between Pennsylvania and Maryland which bears their names. The clock was recalled by the society to

be sent with Captain Cook in H. M. S. *Endeavour*, to be used in observations of the transit of Venus in June 1769 from King George's Island (now better known as Otahete) in the Pacific Ocean. Later this clock was used by Nevil Maskelyne on the Scottish mountain Schiehallion in his observations of the deflection of a plumb line caused by the attraction of mountains, and in 1819 it was taken to the Arctic by Edward Sabine, who was the astronomer in Parry's expedition.

From 1778 to the Present

Joseph Banks, who was aboard the *Endeavour* with Cook, later became president and held this office from 1778 to 1820. In addition to making contributions of his own in botany he did a great deal to encourage advances in astronomy, meteorology, and geodesy. During his presidency Henry Cavendish and James Watt made discoveries about the composition of water, Herschel discovered Uranus, and Volta sent the society accounts of his discoveries in the field of electricity. The brilliant Humphry Davy steered the society's affairs from 1820 to 1827.

The listing of a few names will show that the great tradition established in the first half of the society's existence has been maintained and even enhanced. Michael Faraday, John Dalton, Clerk Maxwell, Lord Kelvin, J. J. Thomson, Lord Rayleigh, Lord Rutherford, and William Bragg are among those who have made great contributions in the physical sciences. Charles Lyell, Joseph Hooker, Charles Darwin, Thomas Henry Huxley, Lord Lister, Charles Sherrington, and Alexander Fleming are among those whose contributions in biology have not only brought material benefits to mankind but have also altered his philosophy of life.

The Fellowship Today

In the mid-19th century the society took steps to revise its election procedure so that only those with significant scientific attainments in original work became fellows. From this time onward scientists predominated in the fellowship, and the society began to assume the character it has today. Since this is a purely private and nongovernmental body, the fellows themselves determine who shall join them. The annual election of 25 fellows and four foreign members is quite the most important of the annual activities. About 300 candidates, all British subjects or citizens of Eire and each proposed by at least six fellows, are first carefully considered by one or more of the eight sectional committees, dealing, respectively, with mathematics, physics, chemistry, engineering sciences, geology, botany, zoology, or physiological and other medical sciences. Each committee makes nominations, and thereafter the council, with the help of elaborate machinery for appraising the qualifications of those with borderline or general claims, selects 25 names for the fellowship. These selected names are then submitted to the fellowship, which makes the election. Foreign members, at the rate of four each year, are similarly selected by the council and voted into the society by the fellows. On 1 April 1960 there were 614 fellows; most of these reside in the United Kingdom, but there are 24 in Canada and 19 in the United States. Of the foreign membership of 63 on 1 April 1960, 21 members reside in the United States, 11 in Sweden, seven in France, seven in Germany, five in Switzerland, and less than five each in Denmark, the U.S.S.R., the Argentine, Austria, and Belgium. Of 51 Nobel laureates in the society, 23 are fellows and 28 are foreign members. Special statutes, used sparingly, make possible the election of royal persons and individuals who have rendered conspicuous service to the cause of science or whose reputation in other fields is such that their election would be of signal benefit to the society. Thus, King Gustav VI of Sweden, the Duke of Edinburgh, and Sir Winston Churchill are fellows. In all, the fellowship constitutes an influential body dedicated to the cause of science.

A facsimile of Newton's original reflecting telescope. [Science Museum, London]

Publications and Meetings

As a learned society, the Royal Society is concerned, first, with encouraging the search for new knowledge. This it does principally through its publications and meetings. Last year it published nearly 300 papers in its *Philosophical Transactions* and *Proceedings*, each issued in two series, *A* and *B*, the former relating to the physical sciences and the latter to the "B" or biological sciences. At the weekly meetings original work is presented and discussed, sometimes in the form of new papers, sometimes as lectures on special topics of current concern to the society. In recent months space research, IGY results, stellar evolution, and the biology of the South Temperate Zone have been among the discussion-meeting topics. On these occasions world leaders in the subject under discussion are invited to London to participate.

In addition to the journals reporting original work, the society issues annually the *Biographical Memoirs of Fellows of the Royal Society*, consisting of authoritative statements on the life and work of recently deceased fellows and constituting a highly valuable source of historical scientific information. Each year, also, the society publishes a *Year Book* and usually two issues of *Notes and Records of the Royal Society*. The latter publication consists of records of current events and interesting historical notes about the society's past. For the tercentenary celebrations two books are being specially prepared—*The Royal Society, Its Founders and Origins*, edited by Sir Harold Hartley, and *A Brief History of the Royal Society*, by Professor E. N. da C. Andrade. Both are interesting and valuable modern evaluations of their subjects. Happily, too, the society is able in this tercentenary year to publish the first three volumes of *The Correspondence of Isaac Newton* as a tribute to its greatest fellow.

The society maintains a library of some 150,000 volumes, specializing in collections of the periodical publications of sister national academies and works on the history of science and mathematics. Adorning the walls of the society's rooms in Burlington House is a fine collection of portraits of scientists, many of them by famous artists.

Some Current Activities and Public Duties

The council of the society, the membership of which is carefully regulated to maintain an appropriate balance of scientific interests, is thoroughly representative of the fellowship of Britain's most authoritative scientific body. It is assisted in its work by more than 100 committees or subcommittees, covering a very wide range of scientific activities. Some are concerned with research appointments made possible by benefactions from donors anxious to further scientific advance; some, with scientific

The library of the Royal Society at Burlington House.

expeditions; and a new one, with support for school teachers who wish to do research.

The esteem in which the society is held has resulted in its being asked to undertake many duties, some of them by the government. Thus, the society administers parliamentary grants-in-aid for scientific investigations, publications, and international relations; it is responsible for the scientific program of the National Physical Laboratory; and it is a custodian of the standard yard and standard pound. Over 100 of its fellows serve, in the society's name, on other bodies, including the governing bodies of universities, schools, and research organizations of all kinds and many government committees. The president is consulted on practically all senior scientific appointments in the government service, including, by act of Parliament, all new members of the senior research councils for agriculture and medicine and the Department of Scientific and Industrial Research.

The author at his desk in Burlington House, London, headquarters of the Royal Society. Shelton's clock stands behind him at the right.

International Relations

From its beginning the society has had the most friendly relations with scientists in foreign countries, and this relationship continues, not only directly with sister academies and societies overseas but also through the International Council of Scientific Unions (ICSU) and its scientific unions, to which the Royal Society adheres on behalf of Great Britain. In the work of the special committees of ICSU for the International Geophysical Year, antarctic research, space research, and oceanic research, British national committees of the Royal Society all play an active role. Professor Sydney Chapman, the international president for the IGY, was the first chairman of the British National Committee which coordinated the British IGY program. As part of the British program the Royal Society's IGY Antarctic Geophysical Station on the coast of the Weddell Sea was set up, on the shore of Halley Bay, named after Edmund Halley who was so prominent a pioneer in geophysics.

The first meeting of ICSU's committee on space research was held at Royal Society headquarters, and the society's National Committee is giving scientific leadership in Britain's space program. Part of this program is being actively developed in cooperation with U.S. space scientists and involves instrumentation to be flown in a satellite due to

Burlington House, London, from the courtyard. The Royal Society has occupied these quarters since 1873.

The Duke of Edinburgh and Surgeon-Commander D. G. Dalgleish at the Royal Society's International Geophysical Year exhibition.

be launched by a Scout rocket in the United States next year.

The society has played a leading part in the history of ICSU and of its predecessors. It was in 1899 that, along with a group of German academies and the French, Russian, and United States academies, the Royal Society proposed establishment of an International Association of Academies. World War I interrupted the work of this association, but in 1918 the Royal Society took steps to revive it. Shortly after the armistice, the International Research Council was formed in Paris, and Sir Arthur Schuster, foreign secretary of the Royal Society, became its first secretary. In 1931 British representatives proposed certain constitutional changes which resulted in a change of name to the International Council of Scientific Unions. From 1918 until 1958, when the ICSU general assembly met in Washington, successive secretaries of these bodies have been fellows of the Royal Society. In 1958 Sir Rudolph Peters succeeded Lloyd Berkner as president of ICSU. The Royal Society looks forward to welcoming ICSU's general assembly to London again next year, in September 1961.

Relations with North America have always been close. Since Winthrop's admission to the fellowship on 1 January 1662, the roll of fellows has included many from America. Among the earliest were William Penn, founder of Pennsylvania; William Byrd; William Burnet, governor of New York and New Jersey (1720-1728) and of Massachusetts (1728-1729); Cotton Mather; and Elihu Yale, after whom Yale College was named. Benjamin Thompson, Count Rumford, was elected in 1779. Among his subsequent benefactions to the Royal Society was establishment of the Rumford Fund, to provide recognition for research on heat and light. He made a similar gift to the American Academy of Arts and Sciences; the Royal Society's award was to be made for work published in Europe; the academy's, for work published in any part of the American continent.

In June 1937 when Professor L. J. Henderson of Harvard, foreign secretary of the National Academy of Sciences in Washington, was attending a meeting of the Royal Society Dining Club (frequently attended by Benjamin Franklin in his time), he suggested that an annual scientific lecture should be delivered alternately in London and in Washington, by an American scientist invited by the Royal Society and a British scientist invited by the National Academy. The Pilgrim Trust generously promised to provide an annual honorarium for six years. The first Pilgrim Trust lecture was delivered in London by Irving Langmuir in 1938; the second, by Sir William Bragg in Washington in April 1939.

In the dark days of World War II, in March 1941, the president of the Royal Society, Sir Henry Dale, was greatly moved by the sentiment which prompted the American Philosophical Society to send a gift of $10,000 to the Royal Society for the aid of science and learning in Britain. In his message sent with the gift, Edwin G. Conklin wrote, "We make this gift in filial regard for the Royal Society which was the model upon which Benjamin Franklin in 1743 founded 'The American Philosophical Society for Promoting Useful Knowledge in the British Plantations in America' and as evidence of the spirit of friendship and common purpose among men of science in both countries."

Friendly cooperation between the Royal Society and scientific institutions in the United States is nowadays a commonplace. Every month many fellows are in the United States, and the two scientific communities are in constant intimate touch. We are especially pleased that so many American scientists are among those due to participate in our tercentenary celebrations this summer. Friendly encouragement such as this, from so many parts of the world, will stimulate the Royal Society of London to go forward into its fourth century seeking, as ever, to advance "Natural Knowledge" through the methods of scientific experiment.

An Evaluation of Existing Fallout Collection Methods

Analysis of data shows that open vessels and funnels are equally efficient for fallout sampling.

George A. Welford and William R. Collins, Jr.

Since 1951 considerable attention has been focused on the measurement of the deposition of radioactive debris from nuclear detonations. It has been ascertained that about one-third of this material never leaves the immediate vicinity of the detonation and is deposited as close-in fallout (*1*). The remaining by-products of the explosion are dispersed over the earth's surface by transport through the atmosphere.

The greatest single determinant of where and how soon fallout occurs is the original placement of the radioactive particles in the atmosphere. Tropospheric particles are generally limited in latitudinal spread and have a mean atmospheric residence time of about 30 days. Stratospheric fallout has been explained with varying success by several theories (*1, 2*), but it is agreed that particles introduced into the stratosphere deposit more slowly and in patterns which are quite different from those of tropospheric debris. In addition to the size of the detonation, many other factors, such as the site and altitude of burst, determine the placement of the debris in the atmosphere. While the effects of many of these factors may be estimated, the final practical requirement is the measurement of fallout on the ground.

At first glance, native soil would appear to be the best sampling medium. The analysis of soil, however, is complex and subject to large relative errors. Soil sampling is therefore reserved for cumulative or long-term measurements. Many sampling techniques have been tried for the approximation of natural ground deposition conditions. Devices employing planar, conical, and cylindrical collection surfaces have been employed to increase particle retention. Compact and combustible materials such as organic films and ion-exchange resins have been utilized to facilitate sampling, handling, and analysis.

Since individual sampling methods may be affected differently by the physical and meteorological factors controlling fallout, their efficiencies may be quite different. Therefore, an understanding of the characteristics of collectors is necessary before analytical results may be related. Eisenbud and Harley (*3*) have discussed the efficiency of gummed film relative to high-walled pots. Libby (*4*) and Eisenbud (*5*) have evaluated soil samples as a means of measuring deposition rates. Collins and Hallden (*6*) have compared a funnel-reservoir collector with pots and open tubs. Welford and Harley (*7*) have compared a funnel-resin system with pots. Rosinski (*8*) has compared an artificial grass sampler with gummed film and pots.

The over-all relationships among collector types is still vague because of the limited scope of previous observations and the lack of an absolute standard collector. This article presents a broader analysis of existing data and new evidence on the behavior of specific nuclides in fallout material.

Sampling Methods

The open-vessel collectors show great variations in exposure area. The open vessels most commonly used for monthly collections are stainless steel or plastic high-walled pots with an area of about 1 square foot. Shorter-term collections require larger exposure areas, of several square feet, and are usually made with plastic or metal-lined trays provided with runoff reservoirs. These vessels are exposed in the open during the sampling period, then the contents are removed for analysis.

In gummed-film samplers (*3, 9*), the sampling medium is a rubber-base cement spread on a 13- by 13-inch cellulose acetate backing and covered with glassine paper for protection. For sampling, the glassine paper is removed and the film is attached to a cadmium-plated steel frame having an opening of 1 square foot. The frame is held 3 feet above the ground on a stationary metal stand. Each paper is exposed for 24 hours. At the end of the sampling period, fresh films are put in place on spare frames. The exposed films are stripped off their frames and folded, with the gummed sides together, to a size suitable for handling.

There are two types of funnel systems (*6, 7, 10*). One funnel-reservoir system consists of a 1-liter polyethylene bottle equipped with a wide-mouthed cylindrical funnel with a conical base. The assembly is enclosed in a wooden container which is opened manually during rain and closed at other times. After exposure, the bottle may be removed for analysis of the contents.

The funnel ion-exchange collector (Fig. 1) consists of a funnel, an ion-exchange column, and a leveling device constructed from polyethylene. The funnel is welded to a threaded cap which is attached to the top of the ion-exchange column. The bottom of the column is also threaded for a tapered cap with attached leveling tube. The leveling device is a plastic tube extended from the bottom of the column to a Y tube above the filter in the column.

The ion-exchange column is packed with a paper pulp filter (Whatman No. 41 filter paper), anion-exchange resin (the chloride form of Amberlite IRA 400), and cation-exchange resin (the hydrogen form of Dowex 50 X-16). An electric heating device is suspended from the eye hook shown at the top of the wooden collector housing to prevent freezing during cold weather. At the end of the exposure period the entire column may be removed from the funnel and leveling device, capped, and shipped to the laboratory for analysis.

The artificial grass sampler (*8*) consists of two parts: an artificial grass surface and a stainless-steel reservoir. The 3- by 0.5-centimeter "grass" blades are cut from cellulose acetate sheets 0.01 inch thick and are coated with an adhesive—a resin dissolved in a volatile solvent. Antistatic materials are used

The authors are staff members of the Health and Safety Laboratory of the U.S. Atomic Energy Commission, New York Operations Office.

Table 1. Comparison of the efficiencies of gummed film and roof pots as determined by activity levels found in New York during April 1958.

Nuclide	Activity level (mc/mi²)		Relative efficiency of gummed film (%)
	Gummed film*	Roof pot†	
Sr^{89}	1.87	16.6	11
Sr^{90}	0.20	3.33	7
Cs^{137}	0.81	4.37	19
Zr^{95}	97.0	128	76
Ce^{144}	24.0	53.2	46
Y^{91}	25.9	51.5	50
Total β activity	103	191	54

* Collection area, 1.0 ft². † Collection area, 0.82 ft².

to eliminate electrostatic effects. Ion-exchange membranes are used to absorb soluble material in the reservoir. Both the grass and the ion-exchange membrane components of the sample are ashed for analysis.

Evaluation of Data

The final test of any collector is its performance under field conditions. Since there is no absolute collector, this evaluation of performance must be based on an arbitrary standard. The pot has been chosen as the standard collector, since most existing data on fallout levels are based on pot collections.

In 1955, Eisenbud and Harley (*3*) estimated the efficiency of gummed film for collecting mixed fission products to be 63 percent in relation to that of pots, for daily collections. In 1957, Rosinski (*8*) estimated this ratio to be about 22 percent for weekly collections. This difference is reasonable, since gummed film is known to lose its retentiveness with extended exposure. In April 1958, total activity in pooled daily gummed-film samples from New York was 54 percent of total activity in pot samples. Radiochemical analysis of these samples showed that the efficiency of gummed film varied for different nuclides. These data, for averages of replicate collections, are listed in Table 1. When the pot values are taken as 100 percent, the average efficiencies for gummed film for the isotopes listed in the table vary from about 10 percent for the strontium nuclides to 76 percent for zirconium.

Two sources of data are used for comparison of the efficiencies of open vessels of different areas. Strontium-90 data listed by Collins and Hallden (*6*) from tub and pot collections made in 1956 are listed in Table 2. The average relative efficiency of open tubs, calculated from these data, is 124 ± 49 percent. Tables 3 and 4 list reported Sr^{89} and Sr^{90} data from Pittsburgh, Pa., and Westwood, N.J., respectively, in 1958 (*11*). Since short-term tub collections were made, the values shown represent monthly totals. In Pittsburgh, the relative efficiency of open tubs was 100 ± 39 percent for both nuclides, and in Westwood, 89 ± 4.5 and 80 ± 3.6 percent for Sr^{89} and Sr^{90}, respectively.

Table 2. Comparison of findings for open-vessel collectors with respect to Sr^{90} activity levels found in the New York area during 1956 (*6*).

Sampling month	Sr^{90} activity level (mc/mi²)	
	Tub*	Pot†
Mar.	1.3	1.9
Apr.	1.0	0.8
May	1.5	1.0
June	1.4	0.8
July	0.6	0.6

* Collection area, 0.82 ft². † Collection area, 2.6 ft².

Funnel systems constitute the third category of collectors. Within this category the major difference in samplers is difference in the depth of the funnel. Two types of funnel, both of 12-inch diameter, were exposed in New York during the fall of 1957, one 6 inches and the other 1 inch in depth. The data obtained are listed in Table 5. Little influence of depth on the efficiency of the collector is evident.

In New York City during 1958, the relative efficiency of funnel collectors with respect to pots was found to be about 88 percent for total beta activity. This was determined from replicate monthly collections made over the 1-year period. Subsequent radiochemical analysis yielded the following efficiencies for individual isotopes: strontium-89, 82 percent; strontium-90, 91 percent; zirconium-95, 94 percent; cesium-144, 79 percent.

The synthetic grass collector described by Rosinski has an efficiency of about 150 percent with respect to pots exposed under the same conditions (*8*). This estimate is based on total beta activity measurements at several sites during 1957.

Finally, the pot as a collector has been evaluated against soil. For a carefully selected sampling site and an accurate strontium-90 analysis, measurement of the soil content of strontium-90 should give the best estimate of accumulated deposition. From data reported for New York for pot analyses

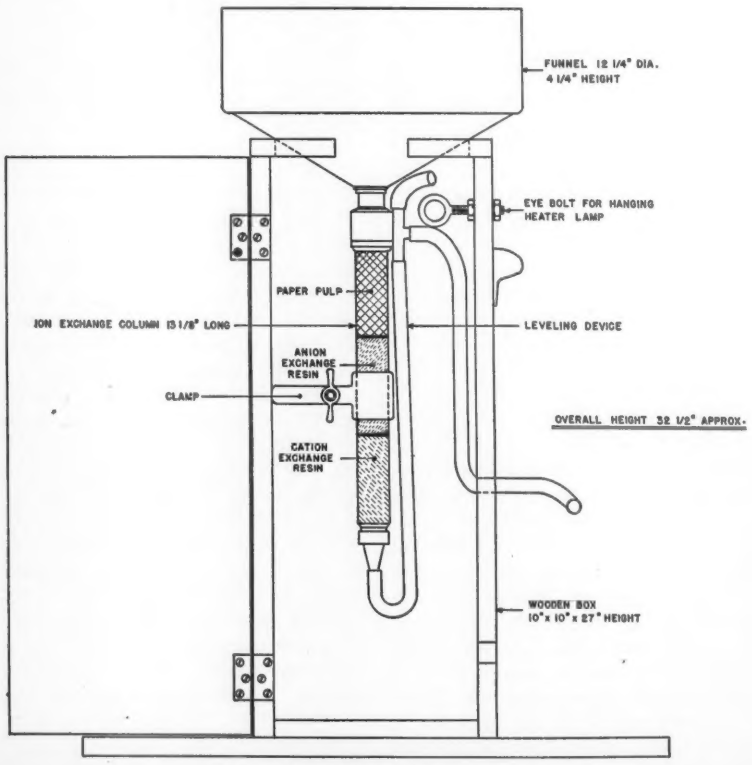


Fig. 1. Ion-exchange fallout collector.

Table 3. Comparison of findings for open-vessel collectors with respect to Sr^{89} and Sr^{90} activity levels found in Pittsburgh during 1958 (*11*).

Sampling month	Sr^{89} activity levels (mc/mi²)		Sr^{90} activity levels (mc/mi²)	
	Tub*	Pot†	Tub*	Pot†
April	20.6	11.2	1.80	0.87
May	21.3	7.4	2.21	0.75
June	16.7	28.7	1.45	2.22
July	67.4	76.2	1.81	2.03
August	29.9	34.1	1.24	1.46
September	13.4	14.0	0.61	0.59
October	11.3	12.7	0.33	0.49
November	20.6	20.3	0.69	0.64
December	15.9	15.8	0.49	0.66

* Collection area, 2.6 ft². † Collection area, 0.82 ft².

Table 4. Comparison of findings for open-vessel collectors with respect to Sr^{89} and Sr^{90} activity levels found in Westwood, N.J., during 1958 (*11*).

Sampling month	Sr^{89} activity levels (mc/mi²)		Sr^{90} activity levels (mc/mi²)	
	Tub*	Pot†	Tub*	Pot†
April	32.4	31.8	1.60	1.73
May	26.0	26.4	2.75	2.81
June	13.2	10.6	1.06	1.05
July	29.0	36.2	1.85	1.11
August	21.0	20.7	0.86	1.10
September	12.5	15.5	0.65	0.70
October	45.9	64.5	1.25	1.64
November	51.8	43.8	0.83	1.38
December	12.8	20.7	0.47	0.79

* Collection area, 2.6 ft². † Collection area, 0.82 ft².

Table 5. Comparison of findings for funnel collectors of different shapes with respect to activity levels found in New York during January 1958.

Nuclide	Activity level (mc/mi²)	
	Funnel depth, 6 in.	Funnel depth, 1 in.
Sr^{90}	1.46	1.09
Cs^{137}	1.02	1.31
Zr^{95}	34.6	34.7
Ce^{144}	13.6	16.8

Table 6. Strontium-90 activity levels found in three replicate pot collections in New York during 1958.

Sampling month	Sr^{90} activity level (mc/mi²)		
	Analyst A	Analyst B	Analyst C
June	1.18	1.76	1.50
July	1.48	1.58	1.61
August	0.52	0.60	0.65
September	0.71	0.65	0.52
October	1.70	1.06	1.41
November	1.18	0.98	1.14
December	0.91	1.77	1.64

made since 1954 and for three annual soil analyses (*11, 12*), the over-all ratio of pot values to soil values was calculated to be 1.11 ± 0.072. By combining this pot-to-soil ratio with the ratio for funnel to pot, the funnel-to-soil ratio was estimated as 0.98.

Although each of these comparisons of sampling techniques was made on collections from a single location, there is still the question of reproducibility of a single type of sampler. Table 6 lists the strontium-90 activity levels in collections from three pots exposed simultaneously for monthly periods from June to December 1958 in New York City. The collections from each pot were analyzed by a different laboratory for strontium-90 content. Variance analysis shows that, at the 95-percent confidenee level, there is no significant difference in the results for the three pots.

The results of analysis of pot and funnel collections made in New York City during 1958 and of tub collections made in Westwood (*11*) allow direct comparison of the three most widely used fallout collectors. Table 7 lists average strontium-90 activity levels found for May through December 1958 in the New York City area. Variance analysis of these data show no significant variation between findings for tub, pot, and funnel, at the 95-percent confidence level.

Conclusions

Analysis of the available strontium-90 data shows cumulative activity levels in New York City pot collections to be slightly higher than those in corresponding soils. The discrepancy is small, however, and quite possibly due to uncertainties in the soil sampling or analyses. Allowing for this and also for possible variations for areas which differ from New York City in topological and meteorological characteristics, we have drawn the following conclusions.

1) Gummed film has a considerably lower over-all collection efficiency than pots. Moreover, it is apparently not uniformly efficient for soluble and insoluble elements. This is undoubtedly due to the runoff characteristics of the flat gummed surface during rainfall.

2) The artificial grass collector retains more activity than other samplers. This is due to the three-dimensional aspect of the collection surfaces with respect to the atmosphere, and to the adhesive applied to the grass blades. Apparently the collector simulates conditions of standing vegetation better than conditions of ground deposition.

Table 7. Comparison of findings for tub, pot, and funnel systems with respect to Sr^{90} activity levels in New York and in Westwood, N.J., during 1958.

Sampling month	Sr^{90} activity level (mc/mi²)		
	Tub*	Pot†	Funnel‡
May	2.75	2.81	2.77
June	1.06	1.05	1.18
July	1.85	1.11	1.48
August	0.86	1.10	0.52
September	0.65	0.70	0.71
October	1.25	1.64	1.71
November	0.83	1.38	1.18
December	0.47	0.79	0.91

* Collection area, 2.6 ft². † Collection area, 0.82 ft². ‡ Collection area, 0.35 ft².

3) The shape of the funnel and the size of the pot or tub have little effect on collection efficiency. Although differences were apparent between tubs, funnels, and pots, in the monthly values for nuclides from fallout debris collected in these containers, these variations were not significant, at the 95-percent confidence level, over a year of observation. Therefore, it appears that the three collection systems most commonly employed are of equivalent usefulness within the expected limits of error from analysis and error from nonuniform deposition (*13*).

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13. Acknowledgments are due our colleagues, Doris C. Sutton and Robert S. Morse, who assisted in many phases of this study, and John H. Harley, who edited the manuscript.

Science in the News

The Drug Inquiry: A Curious Affair That Has Netted Some Solid Results

Senator Kefauver's investigation of the drug industry adjourned last week, after closing on a lively note with exposure of the financial affairs of Henry Welch, who simultaneously headed the antibiotics division of the Food and Drug Administration and held an unacknowledged partnership in several publications promoting the sale of antibiotics. The hearings will resume, probably in the fall, in order to look into the production and marketing of antibiotics, and to give the American Medical Association and other medical organizations a chance to present their views of the situation. But the testimony, during the last two days of the hearings, of Arthur Flemming, Secretary of Health, Education, and Welfare, and of George P. Larrick, head of the Food and Drug Administration, confirmed what was already clear: that whatever complaints can be made about the style of the investigation, no one can say that the hearings have been a waste of the taxpayers' money. Kefauver and his staff are coming up with some solid results.

These results have, for the most part, developed out of the publicity given the hearings, which the hearings won, in part, through the way in which they were conducted. The committee's chief counsel, Paul Rand Dixon, is a vigorous man and, as one FDA official put it, an "old-fashioned crusader." Kefauver himself, in his more reticent way, shares this spirit, and if they conducted an investigation that is more an exposé than a restrained inquiry, it must be noted that they have exposed some things which almost everyone, including, privately at least, some members of the drug industry, agree deserved to be exposed.

The burden of their case has been that the larger companies, through their ability and practice of spending enormous amounts of money on advertising and promotion, have put themselves in a position where they can and do set drug prices far above the basic cost of manufacture. Kefauver cites as an extreme example the case of reserpine; Ciba sells this drug to druggists under the trade name Serpasil at $39.50 per thousand tablets and at the same time has sold the same product to the government for 60 cents per thousand. This is possible, says the committee, because the government buys the drug under its generic name, forcing the company to meet the competition of smaller firms. The public buys the drug from the physician, who specifies the trade name, and since the company has a monopoly on the trade name it can charge whatever price it sees fit.

Monopoly versus Competition

The committee tends to regard this basic charge as an example of the evils of monopoly, but those members of the drug industry who concede that the investigation is probably a good, if for them an unpleasant, thing, say that competition rather than monopoly is the source of the problem, and probably most economists would agree with them. The committee, and particularly Dixon, tends to regard any questionable use of financial power as an example of the evils of monopoly, but few economists are likely to agree with this broad use of the word as a bogey-term with which to tag almost any questionable situation.

The industry people, as well as several of the witnesses critical of the industry, say the trouble is that a pattern of competition has developed in recent years that makes it necessary for even the most ethical of big companies to join in the high-powered promotion race if they want to maintain their position. They say this has developed out of the immense growth of the industry in the past 20 years, with hundreds of new, although not necessarily important, drug products being developed every year, making it necessary for a company to join the promotional race if it is going to bring its product to the attention of the doctors. There is pressure on every company to match the promotional effort of the least responsible companies. This leads to the spending of a great deal of money to develop new drugs whose principal value may be only that they offer a gimmick on which to peg the promotion, and it leads to a barrage of promotion that amounts to $5000 per doctor per year, much of which tends to be misleading, since its purpose is to sell goods rather than to inform the doctor.

All of this has been publicized in the past, but the value of the Kefauver investigation is that it has aroused the interest of the public by demonstrating clearly how much this pattern of competition costs the sick who have to buy the drugs. It is a pattern of competition that many would normally regard as a wonderful example of the virtues of the American way. It does indeed sell more goods to more people. The question is whether the philosophy of selling more goods to more people is an acceptable basis for running this particular industry.

FDA Testimony

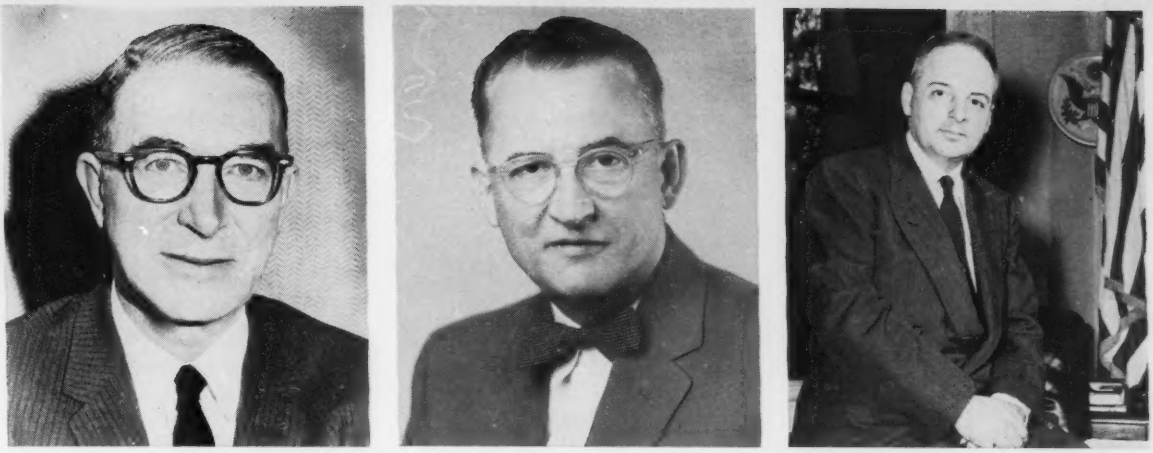
On the question of misleading promotional claims Larrick and Flemming said that FDA had legal, though indirect, means of forcing wayward advertisers to conform more closely to special standards of accuracy in promotion which the position of the industry demands. They promised to make more vigorous use of such powers in the future.

On the more basic question of the cost of drugs they said that FDA has no authority over the price of drugs, nor over the question of whether doctors ought to prescribe by brand name. But as they pointed out, "the activities of the FDA indirectly exert considerable influence" in the matter of generic versus brand name and thus, as the committee has made clear, over the level of prices charged the consumer.

The doctor wants to make sure that the patient gets no substandard drugs. Because of the limited ability of FDA to guarantee that all drugs are up to standard, the doctor tends to prescribe by the brand names of companies in which he has trust. The big companies encourage this practice, and their warnings about the danger of getting substandard products if brand names are not used are not entirely baseless.

Seizure Record

Larrick produced summaries of the FDA's drug seizures over recent years. They showed that during the past 10 years the FDA had to take action only



Senator Estes Kefauver with George P. Larrick, Commissioner of Food and Drugs, and Arthur E. Flemming, Secretary of Health, Education, and Welfare. Larrick and Flemming testified before the Kefauver Committee last week.

four times against any of the 28 largest firms, which produce 87 percent of the nation's drugs. Against the 1200-odd smaller firms, producing the remaining 13 percent of the drugs, the FDA had to take action 484 times during the same period; these figures provide a basis for the doctor's doubts about prescribing by generic names.

Food and Drug Administration officials point out that the situation may possibly be much worse than it appears. For although FDA inspects thousands of drug shipments every year, a statistical study made within the department suggests that the proportion of the hundreds of thousands of shipments annually which are inspected is not large enough to give a reliable index of the quantity of substandard drugs FDA ought to be keeping off the market.

FDA Recommendations

Flemming briefly summarized, and Larrick in a 53-page statement elaborated, the steps they thought ought to be taken. They said they agreed entirely with Kefauver that FDA should be in a position to assure the public and the medical profession that any drugs reaching the market are up to standard. But to do this, they said, FDA needs financial and legal support from Congress. They said that even though the FDA budget has been roughly tripled in the past 6 years, the agency can still maintain a staff of only 500 inspectors to police $70 billion worth of commerce in food, drugs, and cosmetics. As a result, the average drug plant is inspected only once every 2 or 3 years.

Aside from more money, Larrick and Flemming said, the agency needs broader legal powers. They said that FDA needs broader inspection powers; it has the right to inspect a drug company's equipment but not its files. They said that the weak link that leads to substandard drugs is usually inadequate control procedures and that FDA "cannot appraise the control procedures unless it can examine control records and compare these with formulas showing what the firm's personnel are supposed to be doing."

They said that FDA needs the right to examine personnel files in order to see whether the people handling control procedures are qualified for their work. They asked for authority to keep off the market any drugs produced by a plant that did not have adequate controls.

They asked for authority to look at complaint files (usually letters from doctors reporting undesirable side effects), since "we cannot at an early date obtain evidence to evaluate the firm's experience with a new drug as to . . . safety if we are denied authority to review the firm's complaint files."

Flemming said that FDA asked for, and appeared to be getting, a comprehensive factory inspection law in 1953. The proposed law provided that drug factories had to be open to "reasonable" inspection, but as Secretary Flemming put it, "some elements in the drug industry did not want us to have this authority." These elements, sources at the FDA say, were predominantly the Proprietary Association (patent medicine manufacturers) and the National Retail Druggists Association, the latter a very powerful lobby that at the time was closely allied with the patent medicine lobby, although the two are currently quarreling with each other. The ethical (prescription) drug manufacturers were less active and indeed were officially in favor of the inspection law. In any case, senior members of the House Commerce Committee, which had reported the bill, were prevailed upon to hold a colloquy on the floor which, without actually amending the bill, effectively took the meat out of it.

"When this bill says 'reasonable,'" Congressman X would say, "does that mean that an inspector would have the right to look at the complaint files?"

"Why no, certainly not," answered Congressman Y, "I should think that would be entirely unreasonable."

The exchanges filled several pages of the *Congressional Record*, and when they were over it was clear that FDA inspectors had no reasonable right to examine formula files, personnel files, or complaint files.

An FDA official present at this performance says, "Here was a bill affecting the health of everyone in the country. There were about 200 members on the floor. No one questioned what was going on." The next day even the New York *Times* reported only that "the House conducted routine business yesterday."

Lack of Action

None of this explains why FDA has never asked for broader powers again in the years since this 1953 episode. Flemming said it was a mistake not to do so. FDA officials say it was because

they thought the case was hopeless. The public just wasn't interested because it didn't understand what was involved. The people who were most actively interested were against broadening FDA's powers.

Kefauver's Position

All of this is outside the legislative responsibility of Kefauver's Subcommittee on Antitrust and Monopoly. Kefauver cannot bring the remedial legislation to the floor of the Senate. It must come from the Committee on Labor and Public Welfare. But what he has done is to make a public issue of the whole business. If next year the FDA is granted the powers it is seeking, Senator Kefauver's name is not likely to be on the bill, but he and his staff will deserve a good deal, and perhaps most, of the credit.

School Aid Bill in Trouble

It became clear last week that there is a substantial majority in both houses of Congress ready to agree on a compromise school aid bill which the President would sign. Whether members will get a chance to vote the bill through remained very much in doubt. The Senate agreed to submit the bill to a joint conference to work out the compromise, but the House Rules Committee has not yet cleared the House bill for conference, and if it does the effort of House Republican leader Halleck to pack the conference committee with men opposed to school aid may prevent a compromise from being reached. If the bill gets by these hurdles it will then have to go back through the Rules Committee in order to get to the floor of the House for a final vote. HEW Secretary Arthur Flemming is clearly in favor of the compromise, but the White House, as in past years, seems to be making no effort to keep conservative House Republicans from killing the Administration's own proposal.

The compromise, if it gets through, will provide $325 million a year in aid for classroom construction. It will run for four years, with two-thirds of the money going to the neediest states. This is just about what the 1957 Administration bill asked for, but is a long way short of the billion dollar a year program passed by the Senate, which authorized aid for teachers' salaries as well as for classroom construction.

A New Journal of Maps: Biogeography of the North Atlantic

The American Geographical Society, working with a panel set up by the Committee on Oceanography of the U.S. National Academy of Sciences–National Research Council, proposes to publish a scientific journal of an unusual kind, tentatively called *North Atlantic Biogeography*. The journal will consist of maps, accompanied by such explanatory text as may be necessary, and will appear irregularly as contributions are received and accepted. It will be a medium for publication of studies of all kinds—biological, geological, physical, chemical—that will increase our understanding of the marine environment. In scope it will be limited to the Atlantic marine areas, from the equator to the pole, and will include the Arctic basin.

Base Maps Prepared

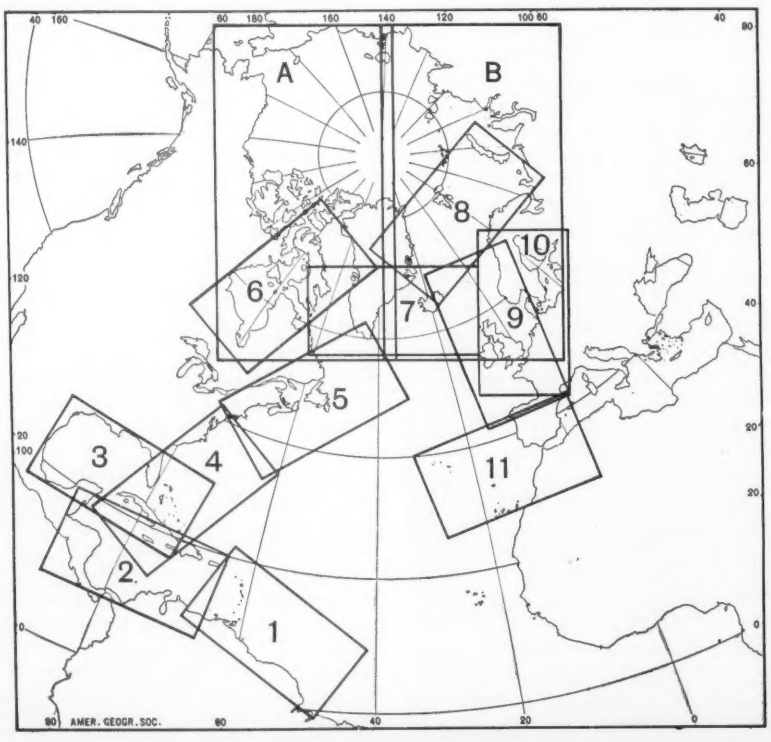
The American Geographical Society has already begun the production of work sheets or base maps for plotting data and has completed, as its first contribution to the project, two sheets covering the eastern North American seaboard from the Labrador Sea to the Straits of Florida. The master sheet, an oblique stereographic azimuthal projection specially prepared for the series, and the proposed layout of large-scale charts are shown in the accompanying figure. Scientists who contribute to the journal will be able to obtain these work sheets at nominal cost from the American Geographical Society (Broadway at 156th St., New York 32, N.Y.).

The journal will be published in atlas size, 24 by 15 inches. It will be available in two editions—on opaque paper or on a transparent material which will be of particular value for comparative studies—and will form an expanding atlas of the North Atlantic.

Journal Meets Growing Need

The new journal will meet a growing need in the study of the environment and of marine organisms and will offer a ready and standard means of recording and comparing distributions. It will be adaptable to almost any relevant purpose a particular author may have in mind.

Often in marine research, as elsewhere, correlations are found which seem significant, then the pattern falls



Sheet layout for the biogeographic atlas.

apart in a few years because of the unsuspected existence of variables not included in the original investigation. Plotting the distribution of as many variables as possible will offer a broader approach to these problems and will uncover critical areas toward which new research efforts may be directed. The journal will also offer marine biologists a means of publishing material gathered incidentally in the course of their investigations—material that might otherwise stand little chance of being reported because of other pressing demands on the research laboratories.

The plan is sponsored in the United States by the National Academy of Sciences–National Research Council, and in Canada by the Royal Society of Canada. Funds are being sought in both countries. The panel is international. It consists of M. J. Dunbar (chairman), Lionel A. Walford, Charles B. Hitchcock, C. O'D. Iselin, Ernest Thompson, C. S. Pittendrigh, T. W. M. Cameron, and H. H. Hess.

Foundation Aids State Academies

The National Science Foundation will in 1960–61 again sponsor science education projects for students and teachers through grants to state academies of science and similar organizations. The 43 grants, to 36 institutions, total $620,000.

A wide variety of projects will be undertaken, including expansion of junior academies of science, scheduling of visits to secondary schools by scientists, and experimental approaches to science education. Illustrative of this variety are some of the projects carried on during 1959–60, the first year of the program.

The Indiana Academy of Science sponsored a series of 250 visits by competent scientists and mathematicians from 19 Indiana colleges and universities to secondary schools.

The Louisiana Academy of Science conducted a Junior Academy of Science Program in which secondary school students carried out research projects and wrote papers describing their results for presentation at ten regional meetings. The best papers were presented and judged at a state meeting.

The Texas Academy of Science sponsored 2-day conferences on research at four Texas universities. These were attended by 400 undergraduates from colleges not offering the Ph.D.

Support by NSF covers items such as the expenses of high school science teachers in attending meetings, the cost of expendable supplies, the expenses of lectures or visiting scientists, and necessary administrative expenses.

News Briefs

Polar expedition. A special Army task force known as Project Lead Dog has left Camp Tuto, near Thule, on an 1800-mile expedition over the Greenland icecap. Accompanied by scientists of the Chemical Corps, Medical Corps, Signal Corps, Quartermaster Corps, Engineering Corps, and Air Force Cambridge Research Center, the 30-man Transportation Corps task force will cross the icecap to Crown Prince Christian Land, will retrace a portion of the route, and will then proceed straight north to Peary Land.

* * *

Weekly Soviet press review. A weekly review of scientific and technical articles appearing in the Soviet press, and of significant new Russian books, is now being published by the Office of Technical Services, Business and Defense Services Administration, U.S. Department of Commerce. Called *Current Review of the Soviet Technical Press* (Order No. 60-21441), the publication is sold on subscription by OTS at $7 for 6 months. The time lapse between the appearance of an original article in a Russian publication and its review in the weekly is no more than a few weeks.

* * *

Chromosome nomenclature. Recently a study group met to formulate a system of nomenclature for human chromosomes, with a view to eliminating the confusion which has arisen from the independent publication of various systems by different workers. As a result of the meeting, a report has been prepared on "A Proposed Standard System of Nomenclature of Human Mitotic Chromosomes." For information write to the secretary of the Human Chromosome Study Group, Arthur Robinson, M.D., Assistant Professor of Biophysics, University of Colorado Medical Center, 4200 E. 9th Ave., Denver 20, Colo.

* * *

New sources of energy. Practical problems and experience on the utilization of solar energy, wind power, and geothermic energy, particularly with reference to less developed countries, will be the subject of a United Nations Conference on New Sources of Energy that is scheduled to be held in Europe from 17 to 27 August 1961. Details about the organization of the conference and conditions for participation will be published shortly in a special pamphlet; this will be obtainable at United Nations Headquarters and at United Nations Information Centers abroad.

* * *

Airborne Television Instruction. Eighteen areas in six midwestern states have been designated as a communications network for the Midwest Program on Airborne Television Instruction. Each of these areas has a major college or university near its center. According to program plans, instructional telecasts will be beamed from an aircraft to schools in the six states, starting in February 1961. The $7-million project is supported by the Ford Foundation and by contributions from private industry. The project has headquarters at Memorial Center, Purdue University, which has prepared a 32-page brochure on the program.

* * *

Undergraduate research. Some 2500 undergraduate students will work with scientists in more than 200 research organizations this summer and during the coming school year as a result of two recently announced National Science Foundation programs. The student research will be supported by 330 grants totaling $1.8 million as part of the foundation's Undergraduate Research Participation and Undergraduate Research Training programs. Students will receive a stipend of up to $60 a week for 8 to 10 weeks of full-time summer work and an average stipend of $150 for academic work on a part-time basis.

* * *

Submarine and space medicine. The Laboratory of Aviation and Naval Medicine at the Karolinska Institutet, Stockholm, has announced that the 2nd International Symposium on Submarine and Space Medicine is scheduled for 18–19 August. The symposium is independent of the 11th International Astronautical Congress, which will be held in Stockholm 15–20 August. The number of symposium participants will be limited to 40 or 50. For information write to the secretary, P.-O. Barr, M.D., Laboratory of Aviation Medicine, Karolinska Institutet, Stockholm.

Scientists in the News

Henry J. E. Reid has relinquished his position as director of the Langley Research Center of the National Aeronautics and Space Administration; he has been director of the Center for more than 34 years. Reid requested that he be relieved of the director's responsibilities and permitted to continue in service during a transition period to assist the new director. His current position is that of senior staff associate.

Floyd L. Thompson, associate director for the past 8 years, has been named director to succeed Reid. Thompson has been affiliated with the Center since 1926.

Henry J. E. Reid

Floyd L. Thompson

Langley was established in 1917 as the first research laboratory of the former National Advisory Committee for Aeronautics, which on 1 October 1958 became the nucleus of NASA. The 710-acre Langley Center has 40 major wind tunnels and specialized laboratories and a dozen shops and other service structures. Virtually every state and several foreign countries are represented among the 3200 employees, one-third of whom are professional scientists and engineers.

While studies of the flight characteristics of airplanes constituted the dominant activity in the early years, the greater part of today's research activity at Langley is devoted to solving problems associated with space flight and re-entry. The balance of its research is in the areas of design and development of aircraft of all types.

Edmund B. Flink, professor of medicine at the University of Minnesota, has been appointed professor and chairman of the department of medicine at West Virginia University.

S. Howard Bartley, professor of psychology at Michigan State University, has been honored by the university with a distinguished faculty award for outstanding contributions in teaching and research.

Lafayette College has awarded a special citation to **Leon S. Stone**, Bronson professor of comparative anatomy in the Yale University School of Medicine, for his notable achievements and researches in the fields of embryology and ophthalmology. He was one of 14 distinguished alumni chosen by the college for citation at a recent convocation.

George A. Llano, secretary to the Panel on Biological and Medical Sciences of the National Academy of Sciences' Committee on Polar Research, has been appointed science specialist (biological sciences), Science and Technology Division, Library of Congress.

At its annual meeting, the Society of Experimental Psychologists, Inc., awarded the Howard Crosby Warren Medal to **Carl Pfaffman** "for his superb investigations of the discriminatory and motivational functions of taste and smell by a powerful combination of neuro-physiological and behavioral techniques."

Harold W. Owens, district geologist for the Humble Oil and Refining Company at Tallahassee, Fla., has won the 1960 George C. Matson Award of the American Association of Petroleum Geologists for his paper on the "Florida-Bahama Platform."

Emmett B. Carmichael, professor of biochemistry and acting department chairman at the University of Alabama, has been named assistant dean of the university's Medical College and School of Dentistry.

Paul J. Burr, USN (ret.), has been named technical services director of the Institute of the Aeronautical Sciences, 2 E. 64 St., New York. The IAS Technical Services Directorate is a newly created staff post; the director is responsible for the compilation and distribution throughout IAS activities of current information in all areas of aerospace technology.

Marvin Fox, director of the sodium reactors department of Atomics International, has joined Hughes Aircraft Company's nuclear electronics laboratory as a senior staff physicist.

Howard T. Evans, Jr., of the U.S. Geological Survey, plans to spend a year in Stockholm, Sweden, where he will work with **Lars Gunnar Sillen** of the Royal Institute of Technology on a physical-chemical study of certain iso- and heteropoly complexes.

H. C. Ludwig Bertele, scientific collaborator of Wild Heerbrugg Ltd., Heerbrugg, Switzerland, received the Photogrammetric Award sponsored by Fairchild Camera and Instrument Co. at the annual meeting of the American Society of Photogrammetry in Washington, D.C. Bertele was cited for his development of the "Super Aviogon" 120° lens.

Christina Lochman-Balk and **James Lee Wilson** have received the Best Paper Award of the Society of Economic Paleontologists and Mineralogists for their paper "Cambrian biostratigraphy in North America," published in the society's bimonthly *Journal of Paleontology* in March 1958. Mrs. Balk is professor of geology at the New Mexico Institute of Mining and Technology, Socorro, and Wilson is a research geologist for the Shell Development Company, Houston, Tex.

Book Reviews

Textbook of Physiology. G. Y. Vladimirov, V. V. Delov, G. P. Konradi, and A. D. Slonim. K. M. Bykov, Ed. Translated by S. Belsky and D. Myshne. Foreign Languages Publishing House, Moscow, 1958. 763 pp. Illus. $10.

By Western criteria this is a poor text. Since a standard text usually reflects the state of development of a science, one might be tempted to make the same judgment of Soviet physiology. Yet, if the importance of a science can be measured by the degree of control it provides over natural phenomena, then there are two major physiological sciences in the world today. Medical physiology, particularly as developed in the West over the past three centuries, has provided the basis for profound control over physical pain and disease; Pavlovian physiology, over the past half century, has become an unprecedented tool for the systematic regulation of behavior. The one is familiar the world over; the other is so little known in the West that its appearance as an instrument in areas of political conflict has provoked an awareness of our own unjustifiable ignorance. It might be asserted that the effectiveness of Russian physiological (as the Russians view them) techniques derives more from their use in a particular sociopolitical setting than from any extraordinary intrinsic merit; yet it must be recognized that most Western scientists know very little about contemporary Soviet physiology, other than the stories of bizzare nerve grafts and heroic cardiovascular resuscitations reported in the popular press. We do not have the understanding and evaluation of the Russians' more solid experiments which are needed to ascertain precisely whence their overt successes spring.

The requisite basic information is now being provided by the systematic translation (initiated by the National Institutes of Health) of Soviet scientific journals. Unfortunately, most of the reports in current issues of these journals refer to earlier work not now available in English. Moreover, basic concepts and their attendant vocabulary are not explained, nor is there any explanation of the aims and methods of experimentation and analysis. These things are taken for granted, as they are in Western journals. Hence, much of the material now available is not intelligible in ways other than by direct comparison with Western data in those cases where the technical methods used were obviously similar, and the incorporation of these new data into Western thought depends on the existence of background information not adequately presented either in the Soviet journals or in our recent reviews. The appearance in English of a Soviet textbook of physiology provides much of this information, as well as some illuminating insights into the Soviet system as it is now being taught to future Russian physiologists.

It is immediately apparent from this text that the origins of both systems lay in 19th and early 20th century European physiology. References by name to the classic experiments of Müller, von Helmholtz, Bernard, Sherrington, Bayliss, Krogh, and others, are as frequent as references to the genuine accomplishments of numerous leading Russian physiologists. The same basic material presented in Western texts is presented here, and the sequence of chapters is strikingly similar: circulation, respiration, digestion, metabolism, excretion, endocrinology, and neurophysiology. There are copious illustrations and diagrams, excellent summaries for each section, and an adequate index. The major differences at this level are the virtual absence of bibliographic references other than to the *Complete Works* of Pavlov and a style in which adjectives such as *incorrect* and *erroneous* predominate over *improbable* and *alternative*.

The fundamental departure of the Pavlovian system (chronologically, this appears to have begun after 1920) is clearly stated in the introductory chapters. Whereas most Western texts begin with a description of cellular physiology, often as exemplified by the properties of blood, and then proceed to the cardiovascular system, the Soviet text begins with an authoritarian exposition of the Pavlovian concept of holistic physiology as the basis for behavioral analysis and then proceeds to circulation. At the outset, Western and Soviet students are presented with complementary views of living matter: on the one hand they are taught that events and processes seen in the separate organs must be related to the laws of physics and chemistry which they exemplify, and on the other hand they are taught that these same events must be related to their subordinate role in the intact, normal animal. Since both systems hold that the central nervous system elaborates behavior, it follows (in the Western view) that (i) all events in an organ are determined primarily by the physicochemical properties of their material substrates, and (ii) one cannot get a clear picture of what the nervous system is operating on unless one first "denervates" the organ under study; whereas in the Soviet view (i) virtually all observed regularities in organ function are the direct result of reflex control by the nervous system, and (ii) experiments on organs isolated from their nerve supply are misleading rather than informative.

An example is the Soviet handling of Starling's law of the heart, the familiar statement that the force of a contraction of the ventricular myocardium is proportional to the degree of ventricular filling by venous pressure preceding the contraction. In Western thought this property is regarded as fundamental to the coordination of cardiac output with venous return and within limits obtains without participation of the nervous system. Since the relationship is abolished by perfusion of the coronary arteries with solutions containing procaine, the Soviet view holds that this property is a neural phenomenon, that it is subordinate to nervous control by autonomic fibers present always in the "natural" state, and that it is at best a subsidiary mechanism and at worst an epiphenomenon. In this view, cardiac output is reflexly regulated by stretch receptors in the great veins which are activated

by changes in venous pressure, acting principally through changes in heart rate.

There are genuine weaknesses in the Western point of view: "denervation" does not necessarily remove all neural tissue from the myocardium or its surrounding connective tissue; and there is, as yet, no firm biochemical explanation of the basis for the relationship between initial length and developed tension. But these are not the basis for the Soviet rejection; rather it is the general postulate that neural control is omnipresent. The weakness of their view lies in the lack of clear comprehension of the physical dynamics of the circulation. The relationship between pressure and volume and the elasticity of the arterial reservoir is nowhere clearly defined. The concept of peripheral resistance as a viscous force (Starling's major contribution in this area) is not mentioned; arteriolar resistance is ascribed to the high rate of blood flow in these vessels—thus thoroughly confusing resistance with perfusion pressure gradient (page 109) —or described with Sechenov's dictum that the arterioles are the "taps of the vascular system"—thus leaving it to the nervous system to turn the handles in response to appropriate stimuli (page 149).

Since Soviet physiology grew up in the context of the behavioral rather than the medical sciences, there is a striking emphasis on the application of measurements of the various organ systems as indices of activity of the nervous system but relatively little discussion of medical applications. As a result those two systems (the gastrointestinal and the circulatory) best suited to behavioral correlation are most adequately covered (perhaps by historical accident, since they were also the two fields of major research by Pavlov). The descriptions of the lung, the kidney, and the endocrine glands are grossly out of date. Inaccuracies are common —the roles of renin and hypertensin, for example, are reversed; the adrenal cortical hormones are given half a page; thyroxin is discussed without reference to intermediary metabolism; water and electrolyte metabolism is presented in conjunction with vitamins and trace minerals rather than with clinical disorders of fluid balance.

In view of the emphasis placed on the contribution of the brain to the function of these several systems, it is remarkable to find the sections on nerves, the brain, and the sense organs in their traditional place at the end of the text. Here there is presented a clear, well-organized description of nervous function as determined by means of the conditioned reflex technique. As in the preceding sections, the elemental organization and content are similar to those used in Western texts, with one major exception—much of the behavioral data is omitted by Western physiology texts and, instead, is found in psychology texts, but the analysis and interpretation proceed along different lines.

Because of their emphasis on the function of the intact, normal animal, the Russians subdivide the brain into a series of longitudinal columns, the motor and sensory "analyzers," rather than into the series of hierarchical segments that form the basis of the Western view. The term *analyzer* includes not only the sensory or motor organ, but also the fiber paths, intervening nuclei, and cortices upon or from which each organ projects; the term *center* does not mean a locus in the brain, but a functional set of structures irrespective of shape or location (page 525). Scant discussion is afforded the properties of spinal, decerebrate, thalamic, and decorticate preparations, apart from emphasis on the common deficits resulting from loss of the cortex. As a result there is no clear picture of how these preparations differ from one another, or of the subcortical mechanisms with which the cortex is operating. By Western standards, discussions of the function and properties of the brain are grossly curtailed in the following areas: the cerebellum; the reticular formation; the tegmental, thalamic, and hypothalamic nuclei; the corpora striata; the rhinencephalic and limbic structures. Closely allied to these elisions is a lack of concern with neuroanatomy. In order to follow the Pavlovian description of brain function, one need only know that the basal ganglia lie between the sensory receptors and the cerebral cortex. No serious attempt is made to describe the cell types or patterns of organization, even in such critical structures (for the Russians) as the neocortex.

My listing these omissions should not be construed as adverse criticism, for above all, the text is comprehensible and achieves its express purpose: to impart an understanding of the Pavlovian view. In this sense, the book might serve as a model of simplicity in handling a complex subject. However, the text can and should be criticized for failing to make clear the shortcomings and inconsistencies which inevitably accrue to such a one-sided, conceptual development. As in the preceding sections, most of the difficulties can be traced to the lack of a serious attempt to base physiology in physics and chemistry rather than in Pavlovian doctrine.

The salient example of this can be found in the treatment of central inhibition, a concept which must lie at the core of any systematic discussion of neurophysiology. The Russian interpretation is based on the phenomenon of Wedensky's block. Sustained or repetitive stimulation of a peripheral motor nerve, by whatever means, leads to a stable, nonpropagated, nonfluctuating state of excitation (called "parabiosis") in the nerve along with submaximal muscular tetanus. In this parabiotic state additional stimuli are found to cause a paradoxical decrease in the force of muscular contraction ("block"), whereas reduction of the intensity or frequency of the sustained stimulus will cause an increase. These paradoxical reactions have been adopted as the basis for the concept of inhibition, which is therefore a suppression (literally a braking) of an excitatory process by superadded excitation (page 544). This block is not regarded as a form of fatigue, but as the result of an incompatibility between the rate of stimulation and the natural cycles of excitability of the structures being stimulated. Every excitatory process carries in it the potentiality of being inhibited by further intensification. This has been elaborated and broadly applied to interpretation of the cortical contribution to the conditional reflex. For example, the suppression of an alimentory, conditioned reflex by an irrelevant stimulus is ascribed to the superposition of the additional stimulation on the sustained excitatory state induced by the conditioning situation. Satiation is ascribed to the development of a parabiotic state due to the prolonged stimulation of feeding, such that further alimentary stimuli produce a reduction rather than an increase in response. Sleep is attributed to the "irradiation" (one of many specialized terms defined in this text) of sustained, hence potentially inhibitory, stimuli over the cerebral cortex, especially when unopposed by excitatory stimuli (for example, unexpected events evoking the orienting or what-is-it reflex), and specifically not to a periodic rise in the activity level of a diencephalic nucleus or sleep center.

In contrast, one Western view of inhibition (stemming largely from Sherrington's work) is based on the hypothesis that two types of nerves or synaptic terminals abut on the somata of motoneurons (or other central neurons) with diametrically opposed effects. Direct evidence for this has been found in the form of electrical recordings from microelectrodes placed in single motoneurons. Excitation has been found to cause a nonpropagated reduction in transmembrane potential ("depolarization") which, if sufficient, initiates a propagated spike, whereas inhibition causes an increase ("hyperpolarization"). Wedensky's block has been associated with a stable reduction in membrane potential resulting from prolonged stimulation, injury, anoxia and so forth, accompanied by both a lowered threshold of activation and a lower margin of safety for spike initiation (since reduction of membrane potential below a critical level will prevent propagated spikes from occurring at all). It is generally regarded as a type of fatigue. These concepts have been elaborated in a variety of conditions and preparations, both vertebrate and invertebrate, leading to the accumulation of a large body of physicochemical data in their support. None of these data are described or even mentioned (page 553). The long discredited Bernstein hypothesis of membrane potential is briefly discussed (page 508) with the valid reservation that semipermeable membranes have not been adequately demonstrated to exist in cells; in other respects, the treatment of electrophysiology is about 25 years out of date.

Pavlov achieved considerable success in describing operational types of inhibition (for example, extinction, differentiation, and delay) as well as stages in the inhibitory process—that is, the "equalization," "paradoxical," and "transmarginal" phases—but his followers seem to be unable clearly to distinguish these types from fatigue (page 554) or from each other: "Not every manifestation in the cerebral cortex can be regarded as transmarginal inhibition, otherwise each extinguished or differentiated stimulus, because of its nonreinforcement, would have to be considered as exceeding the strength limit. . . . But this in no way means that the various cases of inhibition differ in nature and that transmarginal inhibition is a very special state. Pavlov was inclined to regard all cases of inhibition, in their essence, as manifestations of a single process inseparably connected with the process of excitation" (page 638). Inhibition is conceived in some cases as "protecting" nerve cells from fatigue, an unusual instance of introjection of a value term, but one used by Pavlov and, hence, sanctioned.

In view of these multiple omissions, one may well ask wherein the undoubted effectiveness of such a limited system might lie. The answer seems to be that the conditioned reflex technique is a means of precise description and prediction rather than of understanding. It is a symbolic language used to describe behavioral patterns without recourse to theory. On the one hand it does not lead to the joining of physiology with physics and chemistry, which ultimately must afford the basis for explanation. On the other hand it does not require the use of tenuous behavioral concepts such as motivation, reward, punishment, emotion, or memory in order to describe complex patterns of somatic and visceral activity. These and related concepts have alienated many physiologists and have contributed to the present schism between Western physiology and psychology, although they have been productive in the laboratories of those wise enough to use them carefully, and doubtless some day will constitute a valid premiss in the argument between objective and subjective experience.

The roots of this over-simplification would seem to lie in the naive epistemology Pavlov bequeathed to his collaborators, which, apparently, has not been altered in any way in the 24 years since his death. The study of physiology involves the attempt to answer the question about an organ, "How does it work?" To a Soviet physiologist this appears to mean, "What is the observed correlation (law) of events?"; whereas to his Western counterpart it more often means, "What is the major premiss (law) by means of which one event can be said to follow logically from another?" For example, if asked, "How are the eyes moved in nystagmus?," a Western physiologist might attempt to describe a putative imbalance between the vestibular, cerebellar, and oculomotor nuclei, whereas the Russian answer appears to be simply "back and forth" (page 696). Each answer has its virtues. The persistent application of the notion of causality in a simple pragmatic sense has permitted the Russians to amass a vast and consistent literature emphasizing the correlations of input with output of the body. The Cartesian mechanistic approach in the West has produced an equally vast literature emphasizing the effects of direct manipulation of the brain (stimulation, ablation, and application of drugs), marked as much by its variety and flexibility as by its uncertainty and confusion. Essentially, we have not found the physicochemical principles of neural activity, whereas the Russians have not seriously sought them. However, the current 7-year plan for physiology as presented in a recent editorial by D. A. Biriukov in the *Sechenov Physiological Journal of the USSR* calls for precisely this goal. Moreover, this text does not adequately reflect the exceptional vigor and technical competence displayed by Soviet neurophysiologists in their recent publications. Their work will merit careful appraisal in coming years, and this text provides an essential basis for that study.

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The Rites of Passage. Arnold van Gennep. Translated by Monika Vizedom and Gabrielle L. Caffee. University of Chicago Press, Chicago, Ill., 1960. 198 pp. $4.50.

Although van Gennep, one of the original group of Durkheimian sociologists, lived until 1957, this book, originally published in 1908 but not previously translated into English, is the sole basis for his considerable international reputation as a theorist in the field of comparative religion.

Van Gennep saw the life of any individual in society as being marked by a series of transitions from one social status to another: from youth, to maturity, to old age; from single to married; from childlessness to motherhood; from life to death, and so forth. And for each of these events there are, in all societies, special ceremonies whose function it is to enable the individual to pass successfully from the status he is leaving to the one he is attaining.

Such rites of passage—birth ceremonies, marriages, initiations, funerals, rituals of arrival and departure—can, in turn, all be analyzed in terms of their three major subphases: rites of separation, symbolizing abandonment of the old status; rites of transition, symbolizing an interregnum, "social death" period during which the individual is

suspended between the old and new statuses; and rites of incorporation, symbolizing the achievement of the new status. A Brahman youth's ritual bath before initiation as a novice is an example of a rite of separation, a girl's seclusion during her first menses of a rite of transition, and sexual hospitality to a visiting stranger of a rite of incorporation.

In support of his thesis, van Gennep quotes a great variety of material, much of it unreliable, from peoples all over the world. But despite his uncertain scholarship, his generally "botanizing" approach to the categorization of religious practices, and his total failure to deal with the social and cultural contexts from which his examples are drawn, van Gennep offers, in his concept of an underlying pattern of withdrawal, isolation, and return which is common to all passage rituals, a valuable theoretical insight into the dynamics of religion in both psychological and sociological terms.

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Heavenly Clockwork. The great astronomical clocks of medieval China. Joseph Needham, Wang Ling, and Derek J. de Solla Price. Cambridge University Press, New York, 1960. xv + 254 pp. Illus. $12.50.

This is a history, but not a mere chronological account, of the clock in China, from the time of the later Han dynasty (about A.D. 120) through the beginning of the Ming dynasty (about A.D. 1600). The volume, organized in a way which is unusually revealing of the processes by which the authors' research was accomplished, occasionally gives the reader a feeling almost of participating in the research. Beginning with the elaborate astronomical clock of Su Sung (1086–94), which has been mentioned but not fully analyzed in earlier literature, the authors have searched the dynastic histories and encyclopedias, with which Chinese literature abounds, in an endeavor to determine, first, the earliest evidence of such a device in Chinese history and, second, the reasons for the regression in Chinese horology which made it possible for the Chinese to be so impressed with the clocks brought in by the Jesuits in the 16th century. Their search for an answer to the first question leads to Chang Hêng (fl. 120–140), a well-known mathematician and astronomer who is already recognized as an inventor (probably the first) of an instrument for indicating earthquakes. It would appear that the Chinese version of that critical element of the clock, the escapement, was a device demonstrably related to the water clock and, hence, plausibly descended from that older device.

The quest for an answer to the second question is necessitated by the evident impression on the part of both the Jesuits and "the majority of Chinese" that the clock was a new thing in China at the end of the 16th century. The authors conclude, provisionally, that clock-making had not actually ceased, but had been reduced to "a minor industry" 250 years prior to the arrival of the Jesuits, a victim of the attempt of the Ming to efface certain luxuries of the previous dynasty, among them the clocks (page 141). As is acknowledged, this conclusion leaves for further research the actual condition of the "minor industry" when the Jesuits came.

Perhaps the most challenging aspect of this book is its suggestivity concerning the rationale of horology. It appears that Chinese clocks, until late in the 13th century, were principally concerned with the representation of astronomical motions and not with the visual indication of time. The authors suggest a connection between the invention of the "powered celestial globe as a calendrical computer" and the determination of the imperial succession by state astrology (pages 172–73). They conclude with a brief attempt to relate the story they have unfolded to horology in India and the West.

I have mentioned only a few of many intriguing points raised in this remarkable book, which I presume to be a by-product of the first two authors' *History of Science and Civilization in China*. Much of the citation in the present work is to the unpublished volume 4 of that *History*. But it is nonetheless an impressively self-contained piece of scholarship, admirably illustrated and written in a sprightly style that overcomes the drag of an inevitably cumbersome, critical apparatus. Scholarship and elegance of presentation are not often more successfully combined.

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The Nation's Children. vol. 1, *The Family and Social Change*. 252 pp. vol. 2, *Development and Education*. 242 pp. vol. 3, *Problems and Prospects*. 242 pp. Eli Ginzberg, Ed. Columbia University Press, New York, 1960. Paper, 3 vols. for $6.50; cloth, $4.50 each.

In discussing plans for the 1960 golden anniversary White House Conference for Children and Youth, the Conference Steering Committee faced the need for materials to be presented to the delegates to serve as a basis for the discussion that would be "charting directions for the next decade." The feasibility of stimulating research in the multiple areas affecting children and youth in time for use by the conference was rejected; instead, it was decided that the Committee on Studies should invite distinguished experts in a variety of fields to write essays on subjects of current concern about youth today. The essays were to be written for the educated layman, "to strive for balance and eschew extremes."

The collected articles have been published in three volumes, edited by Eli Ginzberg, chairman of the Committee on Studies of the White House Conference. The result is a most interesting panorama of the nation's problems and tasks in regard to our young people.

The first volume deals with some of the social changes affecting family life, such as the new suburbia, urbanization, prosperity, health gains, population increase, changing family role definitions, cultural shifts, increased leisure, and developments in the religious field. The contributors show how these changes influence the family and affect the way youth today see their world. For instance, financial security is shown as creating a sense that one's personal future is safe; this leads to the feeling that one does not have to delay marriage to pursue a career. This picture is also affected by the reduced health hazards in childhood illnesses. With these new forces at work, marital and parental roles and functions are changing. The interplay of these factors is graphically described by the specialists who contributed to this volume.

Development and Education, the second volume, focuses on "the analysis of the gap between our aspirations and our accomplishments in preparing young people for life from three vantage points: how the gap came to be, what can be done to narrow it, and the

extent to which it will probably persist." The problem of the overwhelming tasks given to the American school by the public which seems to be affecting the primary tasks of education, the question of "wasted talent," and the interplay between education and employment are a few of the knotty questions posed and tackled in this volume.

The third volume, *Problems and Prospects*, present some specific groups, such as minority group youth, delinquent youth, and rural youth, which require special help. Evaluation of the effectiveness of help now offered by governmental and other agencies to these youths, as well as to working mothers, low-income families, and children of broken homes, is attempted in this volume.

These volumes offer a wealth of information, much provocative thought, and above all the tasks to be tackled if we are to perpetuate our democratic heritage which will shortly be in the hands of our children. The privilege of obtaining these books is extended to the general public. The paperback volumes can be purchased by writing to the White House Conference for Children and Youth Headquarters, Washington 25, D.C.; the clothbound volumes are available from Columbia University Press, New York.

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Chimica Generale e Inorganica. Giuseppe Bruni. Giorgio Renato Levi and Mario A. Rollier, Eds. Libreria Editrice Politecnica, Milan, Italy, ed. 11, 1960. xxi + 822 pp. Illus.

This famous textbook of general and inorganic chemistry by the late Giuseppe Bruni, which was published in 1921 and which soon became a standard text for Italian universities, now appears in its 11th edition, revised and brought up to date by two of Bruni's most eminent pupils. The first part deals with what we call physical chemistry, the second with systematic inorganic chemistry. The largest chapter is devoted to nuclear chemistry, and the advanced concepts of atomic theory are presented in a form that is remarkable for its simplicity and intelligibility.

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New Books

Biological and Medical Sciences

Morgan, Jeanne. *The Morphology and Anatomy of American Species of the Genus* Psaronius. Univ. of Illinois Press, Urbana, 1959. 115 pp. Paper, $3; cloth $4.

Umbreit, W. W. *Metabolic Maps*. vol. 2. Burgess, Minneapolis, 1960. 287 pp. $5.50.

Wright, Helen, and Samuel Rapport, Eds. *Great Adventures in Nursing*. Harper, New York, 1960. 298 pp. $3.50 (juvenile).

Economics and the Social Sciences

Bauer, Raymond A., Alex Inkeles, Clyde Kluckhohn. *How the Soviet System Works*. Vintage Books, New York, 1960. This study by the Russian Research Center, Harvard University, was originally published in 1956. The book presents an investigation of daily life in the Soviet Union; it is an analysis of such aspects of society as the family, business, education, science, and the church under the Soviet system.

Bell, Daniel. *The End of Ideology*. Free Press, Glencoe, Ill., 1960. 416 pp. $7.50. These essays deal with social change in America during the 1950's. Bell, former labor editor of *Fortune*, is an associate professor of sociology at Columbia University.

Feifel, Herman, Ed. *The Meaning of Death*. McGraw-Hill, New York, 1960. 369 pp. $6.50. The 21 contributors represent the fields of medicine, psychiatry, psychology, physiology, psychoanalysis, philosophy, anthropology, religion, art, and literature.

Gearing, Fred, Robert McC. Netting, Lisa R. Peattie, Eds. *Documentary History of the Fox Project, 1948–1959*. Dept. of Anthropology, Univ. of Chicago, Chicago, 1960. 431 pp. $8.50. Written as a supplement to *A Documentary History of the Fox Project* (1955), this volume includes recent documents and more complete information on the project.

Granick, David. *The Red Executive*. A study of the organization man in Russian industry. Doubleday, Garden City, N.Y., 1960. 334 pp. $4.50.

Hatch, John. *Africa Today—and Tomorrow*. An outline of basic facts and major problems. Praeger, New York, 1960. 289 pp. Paper, $1.75; cloth, $4.

Miscellaneous Publications

(Inquiries concerning these publications should be addressed not to Science, *but to the publisher or agency sponsoring the publication.)*

Equipement electronique pour l'industrie nucléaire Française. P. Desneiges, M. Doireau, L. Koch, T. Weill. International Atomic Energy Agency, Vienna, 1960 (order from National Agency for International Publications, New York 22). 59 pp. $1. A review of nuclear electronics which briefly describes or enumerates electronic instruments used in the physical, medical, biological, and other aspects of the nuclear energy industry, pertaining to the reactor and its utilization, processing of fuel, ore refining and prospecting. The authors work with the Centre d'Etude Nucléaire at Saclay, France.

Geological Survey Bulletin. No. 1071-D, "Geology of the Huerfano Park area, Huerfano and Custer counties, Colorado," Ross B. Johnson, 36 pp., maps, 1959, $1.25; No. 1072-L, "Distribution of silica resources in eastern United States," T. D. Murphy, 12 pp., maps, 1960; No. 1072-M, "Geology and fuel resources of the Mesa Verde area, Montezuma and La Plata counties, Colorado," Alexander A. Wanek, 58 pp., maps, 1959; No. 1087-D, "Geology and uranium deposits of Monument Valley, San Juan County, Utah," Richard Q. Lewis and Donald E. Trimble, 29 pp., maps, 1959, $1; No. 1095, "Bibliography of North American geology, 1957," Ruth R. King *et al.*, 535 pp., 1960, $1.75; No. 1105, "Selected annotated bibliography of gypsum and anhydrite in the United States and Puerto Rico" (contains over 400 annotated references on the geology, geographic occurrences, origins, technology, and uses of gypsum and anhydrite), Charles F. Withington and Marion C. Jaster, 130 pp., 1960, $0.50; No. 1106-D, "Geophysical abstracts 179, October–December 1959," Dorothy B. Vitaliano, *et al.*, 125 pp., 1960, $0.40; No. 1109, "Geologic appraisal of dimension-stone deposits," L. W. Currier, 82 pp., map, 1960; No. 1112-A, "Selenium in some epithermal deposits of antimony, mercury, and silver and gold," D. F. Davidson, 20 pp., 1960, $0.15. *Geological Survey Professional Paper*. No. 272-C, "Review of literature on evaporation suppression," George B. Magin, Jr., and Lois E. Randall, 19 pp., 1960, $0.20; No. 354-C, "Giant waves in Lituya Bay, Alaska," Don J. Miller, 39 pp., 1960. U.S. Geological Survey, Washington, D.C. (order from Supt. of Documents, GPO, Washington 25).

Scientific Studies at Fletcher's Ice Island, T-3, 1952–1955. Geophysical Research Paper No. 63, vol. 2, Vivian Bushnell, Ed. Geophysics Research Directorate, Air Research and Development Command, Bedford, Mass., 1959. 122 pp. Results of field investigations are presented, including a summary of surface meteorological observations, a study of upper air temperatures, and an analysis of solar radiation data.

University of California Publications. Botany, vol. 32, No. 1, "Taxonomic studies in the Phacelia Magellanic polyploid complex with special reference to California members," Lawrence R. Heckard, 126 pp. *Entomology*, vol. 17, No. 1, pt. 4, "A revisional study of the bees of the genus Perdita F. Smith, with special reference to the fauna of the Pacific Coast. (Hymenoptera, Apoidea), P. H. Timberlake, 156 pp. *Geology*, vol. 36, No. 4, "Paleontology and correlation of the Ohlson Ranch formation," Joseph H. Peck, Jr., 10 pp. Univ. of California Press, Berkeley, 1960.

Water Resources Development Centre. *First Biennial Report*. United Nations, New York, 1960. 38 pp. Covers the establishment of the center and its functions and contains a summary of current activities.

Reports

Long-Period Seismic Waves from Nuclear Explosions in Various Environments

Abstract. Large nuclear explosions in the solid earth, the hydrosphere, and the lower and upper atmosphere have generated seismic waves of periods greater than about 5 seconds which have been detected at great distances from the source.

Large nuclear explosions have been detonated in a wide variety of environments including (i) the atmosphere at heights ranging from near zero to about 40 miles, (ii) the hydrosphere at both shallow and great depths, and (iii) the solid earth. In each case, seismic waves of long periods (greater than about 5 seconds) were detected at great distances from the source. This report is a brief summary of the principal evidence now available on this subject, parts of which have already been published in widely scattered places. Some emphasis is placed on unusual features which might not have been anticipated from prior knowledge of seismic wave generation based only on data obtained from small explosions and earthquakes. No attempt is made to give a comprehensive survey of the evidence on seismic waves of short periods,—periods of the order of a few seconds or less—generated by nuclear explosions, or of the dependence of wave amplitudes on yield of the explosion in the case of long-period waves.

Explosions in the atmosphere—near surface. Surface waves recorded at Palisades, New York, from explosions in the air over Nevada and over the Marshall Islands have been reported previously (*1*). Waves corresponding to the fundamental Rayleigh mode in the period range between 14 and 7 seconds were recorded from these Nevada explosions. Waves corresponding to the fundamental Rayleigh mode for each segment of the mixed oceanic-continental path from the Marshall Islands were recorded in the period range between 45 and 15 seconds. Since the original paper was published, new and more sensitive instruments operating at Palisades in the same general period range have detected long-period body waves from Marshall Island explosions. These body waves are of the multiple, surface-reflected types, since Palisades is in the shadow zone for direct *P* and *S* waves.

In the case of the Marshall Island shots, Rayleigh waves similar to those recorded at Palisades were also recorded at many stations (for example, Kogan, *2*) throughout the world, apparently wherever long-period seismographs of adequate sensitivity were in operation. No evidence for generation of Love waves by the Marshall Island shots is known to us.

Long-period waves have also been detected at many stations throughout the world from nuclear explosions at the arctic testing site in Novaya Zemlya of the U.S.S.R. (for example, Brune, *3*). In general, these waves are similar to those from shots in the Marshall Islands, that is, the largest waves correspond to the fundamental Rayleigh mode, regardless of whether the path is simple or complex (mixed oceanic and continental). The periods of these waves range from 50 to 5 seconds, the limiting values in a given case depending partly upon the nature of the path. When ultrasensitive instruments such as those at Palisades were used, long-period waves, including *P*, *S*, and the multiple surface reflections of each, were recorded occasionally.

Seismographs at Uppsala, Sweden, and Agra, India, clearly recorded waves corresponding to the first shear, or M_2, mode from explosions at the arctic site. The Hong Kong station clearly recorded Love waves from arctic explosions. Love-wave generation is extremely unusual in the case of an explosion in the air, and the amplitudes of the Love waves at Hong Kong are an order of magnitude less than those of Rayleigh waves of the same period at that station. There is, however, no question about the identification. Although no official data has been released on the U.S.S.R. explosions, origin times and epicenters deduced from seismic data may be found in the bulletin of the Uppsala seismograph station (*4*). The large air waves, frequently recorded by vertical-component seismographs, as well as microbarographs, suggest that the events took place within the lower atmosphere. For a more detailed study of some waves generated by U.S.S.R. explosions see Brune *et al.* (*3*).

Explosions in the atmosphere—high altitude. The two large nuclear explosions Teak and Orange, fired in the Johnston Island area of the Pacific by the United States in August 1958 unexpectedly generated long-period seismic waves with amplitudes comparable to those generated by the large explosions in the Marshall Islands. According to press reports, Teak and Orange were detonated at altitudes of "about 40" and "about 20" miles, respectively. In contrast, the excitation of short-period seismic waves by high-altitude explosions was apparently very much less than by the near-surface Marshall Island shots. At Palisades, the ultrasensitive instruments detected waves of the fundamental Rayleigh mode as well as body waves, including *P*, *S*, and surface-reflected combinations of *P* and *S*, all with amplitudes comparable to those of the same waves from the Marshall Islands.

Long-period instruments in Honolulu recorded waves corresponding to both the normally dispersed and the inversely dispersed branches of the fundamental Rayleigh mode for oceanic paths. For such paths, the inversely dispersed branch has never been reported when the source was an earthquake. A detailed study of the waves from these high altitude explosions is in preparation (*5*).

Explosions in the ocean. A study has already been published on the seismic waves generated by Wigwam (*6*). This explosion also generated waves corresponding to both the normally and inversely dispersed branches of the fundamental Rayleigh mode. These waves were recorded on the west coast of North America and, after crossing the continent as Rayleigh waves, on the east coast of North America. Waves corresponding to the first shear mode for an oceanic crustal structure were also identified at California stations. The explosion generated unusual *P* and *S* waves as a result of reverberation within the water layer and also made a short-period *T* phase of such intensity that it was felt and misidentified as a local earthquake on the island of Oahu ($\Delta \sim 30°$).

Instructions for preparing reports. Begin the report with an abstract of from 45 to 55 words. The abstract should *not* repeat phrases employed in the title. It should work with the title to give the reader a summary of the results presented in the report proper.

Type manuscripts double-spaced and submit one ribbon copy and one carbon copy.

Limit the report proper to the equivalent of 1200 words. This space includes that occupied by illustrative material as well as by the references and notes.

Limit illustrative material to *one* 2-column figure (that is, a figure whose width equals two columns of text) or to *one* 2-column table or to *two* 1-column illustrations, which may consist of two figures or two tables or one of each.

For further details see "Suggestions to Contributors" [*Science* **125**, 16 (1957)].

Explosions in the solid earth. Surface waves from the two largest nuclear explosions fired deep underground in Nevada were recorded at Palisades. Rayleigh-wave trains very similar to those recorded when the source was in the air over Nevada were detected. Periods of these waves range from about 13 to 6 seconds. In addition, Love waves in the period range between 19 and 7 seconds with amplitudes generally comparable to those of the Rayleigh-wave train were recorded. Identification of these waves is quite certain, being based on measurement of group velocity, phase velocity between Waynesburg, Pennsylvania, and Palisades, surface particle motion, and correlation between the two shots. Furthermore, Love waves in the same period-range were also recorded from one of these underground explosions by similar instruments at Resolute Bay, Northwest Territories, Canada. In this case, the amplitudes of the Love waves are, in general, larger than those of the Rayleigh waves. This surprising result indicates that the heterogeneities of the earth which are effective in producing transverse horizontally-polarized shear waves of short period, as indicated by data from nuclear explosions, are also effective in the case of wavelengths as great as at least 70 kilometers.

A discussion of methods for use of dispersed trains of long-period surface-waves to obtain information on the source, including an illustration based on Rayleigh waves from an underground explosion in Nevada recorded in Wyoming, has been published (*3*).

Most chemical explosions are considerably smaller in yield than the nuclear explosions discussed here. One study of surface waves from very large chemical explosions is that of Kogan *et al.* (*7*). Their results, based on two such explosions, suggest that long-period waves are excited more efficiently by natural earthquakes than by explosions of the same magnitude, but data are limited.

Although there is great contrast between the explosive sources discussed in this paper and natural earthquakes, and although several unexpected waves were generated by nuclear explosions, virtually all the waves so generated can be identified and explained in terms of our knowledge of seismic-wave propagation based on earthquake data. This clearly illustrates the great value of coordination between studies of these two closely related phenomena.

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8. The research reported here was partially supported by the Air Force Cambridge Research Center, the Office of Naval Research, and the National Science Foundation. This report is Lamont Geological Observatory contribution No 419.

4 May 1960

Early Man Site Found in Highland Ecuador

Abstract. Field investigations in Ecuador have produced archeological evidence for the occupation of the northern Andes by early nomadic hunters. Surface collections and test excavations have demonstrated a complex of stone tools with typological relationships to level I at Fell's Cave in southern Chile, and technological relationships to the late Pleistocene "fluted point" complexes of North America. The date of these materials is estimated at 7000 to 8000 B.C.

From 23 January to 7 February 1960 we carried out preliminary investigations at an early archeological site in the Ecuadorian Andes near Quito. We located the site which had been reported to us earlier by Allen Graffham, an Ardmore, Okla., geologist, and collected a large number of obsidian and basalt artifacts from the surface of El Inga, a badly eroded hillslope flanking Ilalo Mountain, near the town of Tumbaco.

Obsidian artifact types found include several styles of projectile points, side and end scrapers, ovate blades, gravers, drills, prismatic blades, microblades, and small hemispheric polyhedral cores. Two projectile point styles appear from field observation to be most significant: the dominant style is a large stemmed point (Fig. 1*A*), identical in form to the points which characterize level I at Fell's Cave in Chile (*1*); one of the several minority styles, found only in fragments, is a lanceolate form (Fig. 1*B*) like the North American Clovis point. Both of these styles are characterized by basal and edge grinding and have irregular channel flakes removed from either one or both faces. They are, in fact, "fluted" points of two distinct forms.

Basalt artifacts are generally irregular, but well-made scrapers, choppers, "pulping planes," and manos, as well as used flakes and cores, have been recovered.

Two test excavations made in one of the uneroded portions of the site demonstrated that the artifacts are contained in the layer of dark soil 12 to 15 inches thick that comprises the soil mantle at the site. These tests clearly demonstrate the feasibility of extensive excavation at El Inga.

Typologically, there seem to be many elements at El Inga previously unknown in South America. The stemmed point of the Fell's Cave type seems the best chronological marker; in Chile it is associated with extinct sloth and horse, and has been dated by carbon-14 at 6900 B.C. The presence of the fluting technique and channel flake removal, as well as the lanceolate form, suggest early North American types. The presence of blades and microblades is rare for South America, but probably also

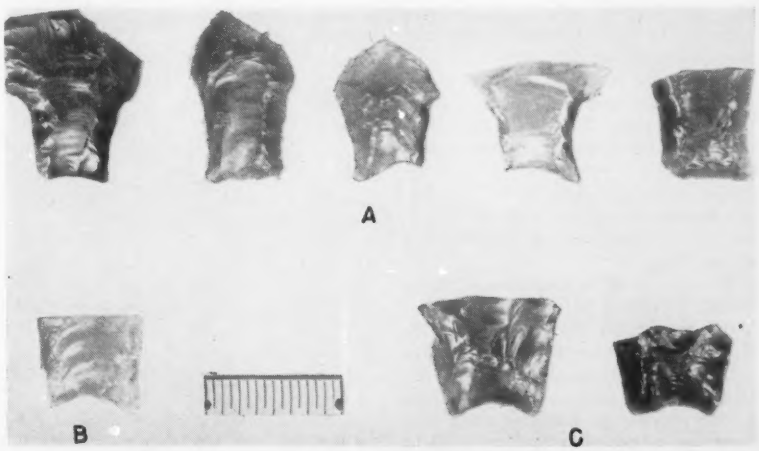

Fig. 1. Projectile points from El Inga, Ecuador. Marker represents 1 inch. (*A*). Fell's Cave (level I) stemmed type (fluted). (*B*). Base of "Clovis fluted" type. (*C*). Thinned bases of lanceolate type.

reflects a relationship with early North American technology.

Samples of the obsidian are being submitted to the Smithsonian Institution obsidian-dating project, but definitive samples must await the major excavation planned for the summer of 1960.

El Inga is considered to be the camp and workshop site of some of South America's earliest men. The inhabitants were probably part of the first wave of migrants from North America, and would thus predate the Fell's Cave people by a thousand years or more. In this interpretation it is quite likely that early North American styles and traits would be most prominent in northwestern South America.

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Reference

1. J. B. Bird, *Geographical Rev.* **28**, 250 (1938).

2 March 1960

Response of Cupressus funebris Tissue Cultures to Gibberellins

Abstract. Gibberellins are a specific growth requirement of tissue cultures derived from the staminate cones of *Cupressus funebris*. The tissue originally required coconut milk for growth. However, a mixture of acid-hydrolyzed casein hydrolyzate and gibberellins replaces the coconut milk entirely and permits even better growth. It is tentatively suggested that coconut milk contains gibberellins or related substances and that these substances are involved in the nitrogen metabolism of the tissue.

Accounts of the effects of gibberellins on intact plants have been accumulating for several years. Stowe and Yamaki (*1*) have recently written two reviews concerned with this literature. Generally, the response of intact plants to gibberellins have been quite striking. These responses are most commonly manifested by spectacular increases in stem length, especially of certain genetic dwarfs, and in flower production by long-day plants with the substitution of gibberellins for the inductive photoperiod.

Attempts to elicit responses of tissue cultures to gibberellins have been rather disappointing. Netien (*2*) tested the effects of gibberellins on tissue cultures of *Helianthus tuberosus, Rubus sp., Daucus carrota,* and crown-gall tissue of *Scorsonera sp.* and observed that there was either no effect or a slight inhibition of growth. Various types of auxin used in conjunction with gibberellins did not change the response appreciably. Henderson (*3*) used tissues of *Helianthus annuus* as the test material and found no appreciable response to gibberellins. Nickell and Tulecke (*4*), in an extensive series of tests utilizing 49 strains of tissue cultures representing 25 species, found that inhibition of growth was the most common result of the incorporation of gibberellins into the nutrient medium. Two tissues died, while several showed a slight increase in weight over the controls. Schroeder and Spector (*5*) reported a synergistic action of gibberellins and indoleacetic acid in the induction of callus growth in explants of mature citron fruit tissue. Gibberellins alone were about one-third as effective as a mixture of gibberellins and indoleacetic acid. The greatest increase in fresh weight was about 100 percent at the end of the experimental period. It can be seen from this short review that plant tissue cultures in general have not been reported to respond very markedly to gibberellins.

The present report is concerned with a spectacular growth response to gibberellins by tissue cultures derived from the staminate cones of *Cupressus funebris*. These tissues were originally isolated by C. D. LaRue in 1954. After his untimely death in 1955, one of us (J. S.) acquired the tissues from his laboratory. The tissues were maintained on White's medium containing 20 percent (vol./vol.) autoclaved coconut milk obtained from mature nuts.

During investigations of certain aspects of the carbohydrate metabolism of the tissue, it became imperative to grow the tissue on a synthetic medium, or at least one which did not include unknown soluble carbohydrates. Consequently, attempts were made to replace the coconut milk with acid-hydrolyzed casein hydrolyzate, indoleacetic acid, adenine, kinetin, and 1,3-diphenylurea. These were used alone and in various combinations. None of the media so prepared permitted much growth of the tissue. However, when a medium containing acid-hydrolyzed casein hydrolyzate (2 gm/liter) and gibberellins (1 mg/liter) was tested, the tissue grew very well. Table 1 summarizes the data obtained with varying concentrations of gibberellins (*6*).

Concentrations of gibberellins between 0.5 and 2.0 mg/liter in conjunction with acid-hydrolyzed casein hydrolyzate permit better growth than coconut milk. Increased concentrations of gibberellins are somewhat inhibitory. Indoleacetic acid was tested for a possible synergistic action with gibberellins. A single concentration of indoleacetic acid of 0.5 mg/liter was tested with media containing different concentrations of gibberellins. In each case, the growth of the tissue was inhibited. The inhibition caused by indoleacetic acid ranged from 40 percent when used in conjunction with 0.1 mg of gibberellins per liter to 58 percent when added to media containing these substances at 2 mg/liter.

Table 1. The effect of concentrations of gibberellins on the growth of tissue cultures of *Cupressus funebris*. CH, acid-hydrolyzed casein hydrolyzate; GB, gibberellins. Concentration of CH in all cases was 2 gm/liter. The basal medium consisted of White's solution, 2 percent sucrose, and 0.9 percent agar.

Addendum to basal medium	Increase in fresh weight after 35 days (%)
None	84
Coconut milk, 20 percent (vol./vol.)	912
CH	228
GB, 1.0 mg/liter	260
CH + GB, 0.10 mg/liter	620
CH + GB, 0.50 mg/liter	943
CH + GB, 1.0 mg/liter	1003
CH + GB, 2.0 mg/liter	1004
CH + GB, 10.0 mg/liter	720
CH + GB, 20.0 mg/liter	538

It is tempting to speculate that gibberellins are somehow concerned with the nitrogen metabolism of the tissue. Without any organic nitrogen added to the medium, gibberellins at 1 mg/liter permit three times the amount of growth obtained on basal medium alone. Acid-hydrolyzed casein hydrolyzate added to the basal medium permits almost as good growth as gibberellins alone. Thus, while the tissues appear to be unable to utilize the inorganic nitrogen in the basal medium, under the influence of gibberellins some utilization is possible. The amount of growth under these circumstances may be limited by the low concentration of nitrate in White's medium (approximately 3.2 mmoles of nitrate ion). We have found that 2 gm per liter is the optimal concentration of the hydrolyzate for these tissues. It would seem, then, that gibberellins enhance the utilization by the tissue of both organic and inorganic nitrogen sources.

One of the implications of this work is that gibberellins or related substances are responsible for some of the growth-promoting activity of coconut milk for these tissue cultures, at least. Radley and Dear (*7*) have shown that extracts of the milk, solid endosperm, and embryo of the coconut accelerate the growth of dwarf peas. They therefore suggest that coconuts contain gibberellin-like substances. In addition, when one considers the report of MacMillan and Suter (*8*), which announced the isolation of gibberellin A from young seeds of the runner bean, and the specific response to that gibberellin by

certain genetic dwarfs of maize and peas (*9*), the probability that higher plants contain and also require gibberellins for growth and development is strengthened.

This work also supports the thesis (*5*) that gibberellins may be involved in cell division. The great increase in the amount of tissue must involve considerable cell division. Without gibberellins and a source of organic nitrogen, growth of the tissue is severely limited.

Cupressus cultures are the only tissue culture which have thus far been demonstrated to require gibberellins in order to attain what is considered to be maximum growth in vitro. It is doubtful that this requirement is associated with the fact that the tissue is of gymnosperm origin, since Nickell and Tulecke (*4*) used pollen-derived tissues of *Ginkgo* and *Taxus* in their extensive study and found no very great response to gibberellins. Ball (*10*), Reinert and White (*11*), and Barnes and Naylor (*12*) have grown tissue cultures derived from various gymnosperms on synthetic media which do not contain gibberellins. In addition, we have tested the effects of these substances on tissue cultures derived from the staminate cones of *Libocedrus decurrens* and have not observed any appreciable effects which may be attributed to them.

Because of their specific response to gibberellins, tissue cultures of *Cupressus* may be an excellent tool with which to study some of the mechanisms of action of these compounds. Tissue cultures permit very close control of environmental, nutritional, and genetic variables, an advantage not afforded by intact plants.

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18 February 1960

Estrogen-like Activity in Vegetable Oils and Mill By-products

Abstract. By the immature female mouse bioassay technique, an increased uterine weight was observed when certain vegetable oils were fed or injected. By-products from the milling of cereals were also capable of eliciting a uterine response.

In the course of evaluation of the estrogenic potency of the coumarin derivative coumestrol (*1*), administered subcutaneously in vegetable oil solution, it was observed that the vegetable oils employed as carriers were themselves capable of eliciting a measurable response in the test animals. Estrogenic activity has been previously reported in wheat germ oil (*2*) and coffee oil (*3*). We have now found that a number of the commonly used vegetable oils are capable of producing estrogen-like responses in mice.

The bioassay employed in our laboratory for measuring estrogenic activity when estrogen is administered orally has been recently described (*4*). In our subcutaneous injection studies, the estrogen, dissolved in a suitable vegetable oil carrier, was administered for four successive days at the rate of 0.1 ml of oil solution per day; the mouse was killed on the 5th day, and the uterine weight was determined as described previously (*4*).

The vegetable oils employed in these studies included samples of commercially available salad oils as well as some unrefined or semirefined samples. Samples of mineral and cod-liver oils were also included for comparison. For oral administration, the oils or cereal fractions were uniformly mixed into the basal feed mixture at levels equivalent to 10 or 20 percent of the diet. The animals were fed in groups of five, and the results presented (Tables 1–3) represent the averages for five animals. Successive repetitions of the test gave very similar results.

The results of oral administration of the oils are summarized in Table 1. Control mice fed no oil beyond that normally present in the stock diet had an average uterine weight of about 9.5 mg at the end of the test period. Some of the oils tested at the 10-percent level of the diet produced uterine weights more than double this value, while others produced lesser effects. Cottonseed, mineral, and castor oil had no effect. The crude coffee oil and isano oils proved toxic, and the mice died before the test was completed. When the oils were administered at the 10-percent level of the diet, each mouse consumed a total of 1 gm of the oil during the period of the assay. Corn oil was slightly more effective when injected (Table 2) than when administered orally. Olive oil was also effective when it was injected subcutaneously.

As has been pointed out by Biggers (*5*), uterine response to oral or subcutaneous administration of a substance is not necessarily indicative that the substance is an estrogen. A true estrogen is also capable of producing vaginal cornification. Levin *et al.* (*2*) were able to demonstrate that a concentrate obtained from wheat germ oil by the Girard-Sandulesco reaction (*6*) produced vaginal cornification in mature, ovariectomized rats.

Since oils from cereal sources showed activity, it was decided to check unextracted cereal products. When wheat

Table 1. Mouse uterine weight response to various oils administered orally. The oils were fed at the 10-percent level unless otherwise indicated.

Kind of oil	Level fed (%)	Mean uterine wt. (mg)
None (control diet)		9.5
Mineral oil	10	8.6
Castor oil, refined	10	9.4
Cottonseed oil, refined	10	10.1
Safflower oil, refined	10	13.6
Wheat germ oil, refined (sample 1)	10	13.6
Cod-liver oil, refined	10	13.9
Corn oil, refined	10	14.2
Corn oil, refined	20	15.8
Linseed oil	10	14.6
Wheat germ oil (sample 2)	10	15.0
Peanut oil, refined	10	15.9
Olive oil, refined	10	16.7
Soybean oil, refined (sample 1)	10	16.8
Soybean oil, refined (sample 2)	10	17.7
Coconut oil, crude	10	19.0
Rice bran oil, refined	10	22.5
Rice bran oil, crude	10	23.1

Table 2. Mouse uterine weight response to vegetable oils injected subcutaneously. Four 0.1-ml injections were given in each case, unless otherwise indicated.

Material	Total vol. (ml)	Mean uterine wt. (mg)
None		9.9
0.9% Saline	0.4	10.3
Corn oil (sample 1)	0.4	13.2
Corn oil (sample 1)*	0.8	18.2
Corn oil (sample 2)	0.4	16.8
Corn oil (sample 3)	0.4	15.1
Olive oil	0.4	12.5

* Eight 1-ml injections.

Table 3. Mouse uterine weight response to cereal fractions fed at the 10-percent level.

Fraction	Mean uterine wt. (mg)
No supplement	9.5
Wheat bran	14.3
Wheat germ	25.6
Rice bran	18.3
Rice polish	21.3

bran, wheat germ, rice bran, or rice polish were fed by incorporating them in the diet at the 10-percent level, uterine weight responses very similar to those obtained with the oils resulted (Table 3).

The findings recorded in this report may be related to observations of growth stimulation in chicks fed high levels of certain fats (*7*). This hypothesis is strengthened by the observations of Carew and Hill (*8*) that diethylstilbestrol stimulated chick growth when it was added to a high fat ration but did not when it was added to a low fat ration, it being assumed that the corn oil used did not supply enough estrogen for maximal response (*9*).

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16 February 1960

Life Shortening and Tumor Production by Strontium-90

Abstract. A linear relationship between dose of internal radiation and two effects, which implies no threshold, is shown to be a possible interpretation of data given by Finkel in "Mice, men and fallout" (*1*). This interpretation is at variance with that offered by Finkel, which was that the dose-effect relationship is nonlinear and indicates a threshold.

In a recent article by Finkel (*1*) the result of a long-term experiment involving radiation to several groups of mice was presented. This was an excellent piece of work which gives us much more information than we have previously had regarding the relationships between radiation, life span, and tumors.

The data from this experiment were presented in such a way as to support the view that incidence of radiation-induced neoplasms does not bear a linear relationship to dose, but does indicate the existence of a threshold level. Doses below this threshold are thought not to produce neoplasms. This view was recently elaborated by Brues (*2*).

After presenting the data, Finkel, in commenting about the graph in which average survival time was plotted as a function of dose, stated that, although parts of the curve suggested a direct relationship between dose and response, it is not a linear one. In commenting on the production of tumors, Finkel stated, "There was a pronounced association between dose and both osteogenic sarcomas and hemangioendotheliomas of bone marrow," but when examining the five lowest dosage levels with regard to osteogenic sarcomas, she said, ". . . the data show no trend and no indication of any relationship between dose and response . . . Therefore, a threshold . . . might lie between . . ."

If Finkel had treated her data differently she might have reached quite different conclusions. In all her figures she plotted the effect against the injected dose in microcuries per kilogram. The amount of internal radiation delivered to an animal injected with a radionuclide is dependent upon several important factors other than the curies per gram injected. In most animal experiments these other factors are considered in calculating the radiation dose in terms of rads. If all of these other factors remain the same between experimental groups, then the results of the different groups may be compared on the basis of curies per gram, as well as on the basis of rads. In Finkel's experiment many of these factors were the same between the different groups, but they differed in one very important factor, that is, time. Some of the groups lived much longer than others, and were thus given radiation doses which were related to their lifetime as well as to the microcuries per kilogram administered.

It is to be hoped that Finkel will calculate an accurate dosage for the different groups in rads. Available information does not permit us to do so. However, we have arrived at a dosage unit which appears to permit comparison between the different groups. The total dosage from injected Sr^{90} was divided into two components on the basis of estimated rapid excretion during the first several days and fairly constant retention thereafter. The first component covers the first 14 days after injection, during which Sr^{90} is being excreted in an exponential manner. We have taken 33 percent (the geometric mean between 100 and 11 percent) of the administered amount as an approximation of the average amount in the body during this initial period. The second component covers the remainder of the average lifetime of each group, or life minus 14 days. We have used Finkel's figure of 11 percent retention as an approximation of the average amount in the body during this period. These approximations of average amounts may be a little low, but the error between groups is probably comparable.

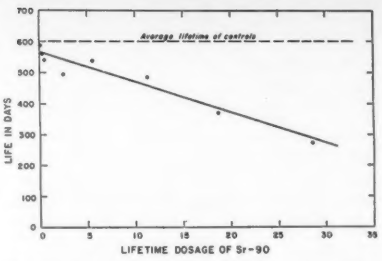

Fig. 1. Relationship between radiation from Sr^{90}-Y^{90} and average lifetime of groups of animals. Dosage is in millicurie days per kilogram.

The average amount of Sr^{90} in the body during each of the two component periods has been multiplied by the appropriate number of days, and the two products added to give a lifetime dose in millicurie days per kilogram.

In Fig. 1 the average lifetimes of the eight lowest dosage groups of Finkel's experiment are plotted on arithmetic paper against dosage in the above-described units. Although there is a moderate scatter of points, they suggest a direct linear relationship, which

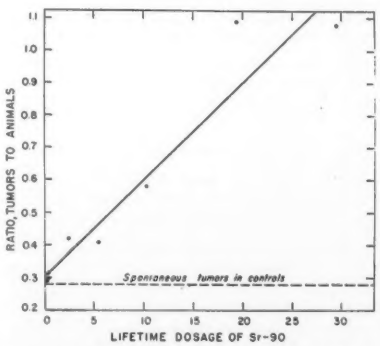

Fig. 2. Relationship between radiation from Sr^{90}-Y^{90} and tumors in groups of animals. The dosage is in millicurie days per kilogram. The ratio of tumors to animals is the sum of animals bearing different types of tumors divided by the number of animals in each group.

apparently approaches zero dose and zero response.

In Fig. 2 the ratio of tumors to animals in each of the eight lowest dosage groups is plotted against dosage in the above-described units. The tumors represented in this graph are the sum of the malignant bone tumors and the reticular tissue tumors reported in *Argonne Natl. Lab. Rept. No. 5597* and the sum of the sarcomas, giant cell tumors, and epidermoid cancers reported in *Argonne Natl. Lab. Rept. No. 5841* by Finkel *et al.* (*3*). Since some animals had more than one type of tumor, the resultant ratio in two of the groups was greater than 1.0. The points on this graph also appear to represent a direct linear relationship between dosage and response which approaches zero dose and zero response.

When presented in this way, the results of Finkel's work can thus be used not only as an argument against the stand taken by Brues (*2*) but can be used to support the views of the United Nations Scientific Committee on the Effects of Atomic Radiation (*4*) and of Lewis (*5*), which are that there may be no threshold for radiation injury, and that the dose-response curve may be straight, extending to zero dose and zero response.

As noted above, in Figs. 1 and 2 only the eight groups of animals having the lowest doses have been used. The four high dosage groups, which were not used, do not continue on the straight line exhibited by the eight lower dosage groups. This alteration of the curve at high radiation levels may be attributed to the fact that at high levels there is considerable "wastage" of radiation. That is, much of the radiation energy is absorbed by dead or dying tissue. Energy which is absorbed by dead or dying tissue is not likely to produce tumors or to shorten life.

In all experience with radiation-induced neoplasms, a latent period between irradiation and resultant neoplasms has been observed. This latent period has been thought to be shortened by larger radiation doses. In Finkel's experiment (*1*) there was an initial whole body radiation dose followed by chronic radiation, primarily to bone. Under these conditions, the longer-lived (low-dose) groups might be expected to exhibit proportionately more neoplasms by virtue of having lived farther past an average latent period. However, this effect might be counteracted by a shortened latent period in the high-dose (shorter-lived) groups.

Without the knowledge to assess the importance of these three factors—initial radiation dose, chronic radiation dose, and possibly variable latent period—one must consider that the linear response suggested in Fig. 2 may be merely fortuitous. However, it gives no comfort to those who would interpret this data as demonstrating a threshold for radiation-induced neoplasia.

In both Fig. 1 and Fig. 2, uncertainties in the values for the points near zero dose as well as uncertainties in the average lifetime of the controls and per cent of tumors in controls are sufficiently great that little reliance can be placed on the exact position or shape of the curves as they approach zero dose.

There are, no doubt, other informative methods of presenting the data from this excellent experiment. In a more recent publication Finkel has presented the data somewhat differently (*6*). This presentation indicates, among other things, an apparent independence of Sr^{90} dose and latent period of resultant tumors.

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11 March 1960

Weber Ratio for Visual Discrimination of Velocity

Abstract. As an approximation based on various experiments reported in the literature, the least detectable difference in speed ($\Delta\omega$) varies in direct proportion to the speed (ω) over a range from 0.1 to 20 degrees of visual angle per second. The constancy of the Weber ratio ($\Delta\omega/\omega$) aids in understanding how men react to velocity in various situations.

Need for information on the Weber ratio has recently been stressed in research on traffic dynamics. Chandler, Herman, and Montroll (*1*) have reported that drivers react mainly to relative velocity rather than to relative distance. This finding provides an experimental basis for models of vehicular interaction which may be applied to multiple collisions on modern superhighways and to other traffic problems.

Fortunately, a rather extensive literature has accumulated on visual discriminations of velocity. Plotting of data from the literature yields a useful generalization. The inference may be applied not only to the dynamics of moving vehicles, but also to other interactions of men with machines.

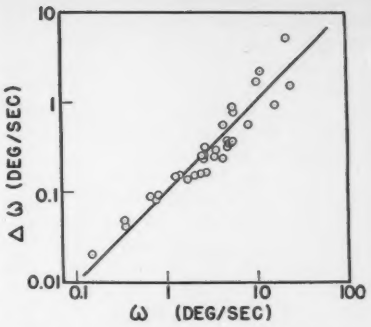

Fig. 1. The differential threshold ($\Delta\omega$) as a function of angular speed (ω). Experimental points are the thresholds as measured in eight experiments (*5*). A least squares solution for the intercept constant yielded the straight line with unit slope; $\log_{10}\Delta\omega = -1.00 + \log_{10}\omega$.

Graham (*2*) has emphasized the importance of expressing extent in terms of the visual angle subtended at the eye. Similarly, it is advantageous to use angular units for velocity. Expression of speed in units of visual angle per second makes it easy to compare measurements which experimenters have made from different distances of observation. In addition, angular speed has advantages for experimental design since its use facilitates the recognition and control of major variables. These and other methodological considerations have been reviewed recently (*3, 4*).

Visual sensitivity to velocity is indicated by the differential threshold, which may be defined as

$$\Delta\omega = \omega_2 - \omega_1 \qquad (1)$$

where ω_2 is a uniform angular speed an observer discriminates, according to a specified criterion, from the constant rate of motion ω_1. The differential threshold has been of continuing interest since the turn of the century; in eight papers (*5*), scientists have reported measurements over a wide range of speeds.

The difference thresholds are plotted against the angular speed in Fig. 1. The straight line of unit slope represents a constant Weber ratio $\Delta\omega/\omega$. Solution for the intercept constant by least squares yields the plotted equation

$$\Delta\omega = (0.10)\,\omega \qquad (2)$$

As a very rough approximation, Fig. 1 shows that the differential threshold in-

creases in direct proportion to the angular speed of the stimulus. Discrepancies result from variations in procedures and from nonrandom effects of major variables. A recent report (*4*) has presented a rationale for interpreting the discrepancies.

The Weber ratio provides a convenient measure by means of which velocity discriminations may be compared with other sensory discriminations and with performances in tracking and predicting. As indicated by Fig. 1 and the least squares solution, the best estimate of $\Delta\omega/\omega$ for an unspecified ω is 0.10. This value is of the same order of magnitude as the Weber ratio for a loudness of 100 db at 1000 cy/sec and for cutaneous pressure at 5 gm/mm^2 and for smell of rubber at 200 olfacties (*6*).

Speed of target motion seems to have the same effect on tracking error as it has on the differential threshold, that is, tracking error increases as a linear function of speed (*7*). In addition, the discrimination of a 10-percent difference in speed agrees with the error a tracker makes when he follows a target which moves at a constant speed but suddenly disappears (*8*). The Weber ratio is also clearly related to predictions of future positions of a moving object (*9*).

Research on tracking and predictive behavior indicates the need to consider the effects of parameters other than speed. It may be anticipated that $\Delta\omega/\omega$, like other Weber ratios, is approximately constant only within a restricted range of stimulus variation, and that the systematic effects of major variables other than speed will become apparent in future experiments. The present report serves to indicate the potential utility which may result from appropriate experimental analyses of the Weber ratio for visual discriminations of velocity.

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7 March 1960

Complementation at the Maroon-like Eye-Color Locus of Drosophila melanogaster

Abstract. Two "allelic" *Drosophila melanogaster* mutants which are deficient in xanthine dehydrogenase can complement one another in heterozygotes. This complementation is due to the production of small amounts of xanthine dehydrogenase, enough of which is present to restore the normal eye color. However, not enough of the enzyme is present to produce normal amounts of the enzyme products, or to reduce the accumulation of the enzyme substrates to levels found in wild-type flies.

Many cases have now been reported in which "allelic" genes can complement each other in heterozygotes or in heterocaryons to produce a wild-type phenotype. Such complementation has been reported for some eye-color alleles in *Habrobrocon* (*1*) and for some wing mutants (*2*) and the bithorax cluster (*3*) in *Drosophila*. The data indicate that restoration of proteins is involved, since, in *Neurospora*, glutamic dehydrogenase is found in heterocaryons of allelic mutants lacking this enzyme (*4*), while a similar situation exists for allelic mutants lacking adenylsuccinase (*5*). This is a report of a similar phenomenon which we have found in *Drosophila melanogaster* between "allelic" mutants which lack xanthine dehydrogenase.

Mutants deficient in this enzyme comprise two loci, maroon-like eye-color (*ma-l*) (*6*) and rosy eye color (*ry*), which are located on the first and third chromosomes, respectively (*7*). As a result of the deficiency of xanthine dehydrogenase, *ma-l* and *ry* mutants accumulate the enzyme substrates (hypoxanthine and 2-amino-4-hydroxypteridine), and show no trace of the products (uric acid and isoxanthopterin) formed from these compounds (*8*). Xanthine dehydrogenase has been purified from wild-type flies by using charcoal, ammonium sulfate, and calcium phosphate gel, and no activity could be detected in purified extracts of the mutants (*9*). In this report we are concerned solely with the *ma-l* locus.

In general, the chromatographic methods followed those described by Hadorn and Mitchell (*10*) and others; the enzymatic techniques followed those described by Glassman and Mitchell (*9*). The amount of xanthine dehydrogenase in the various stocks was determined as follows: Flies were homogenized (40 mg/ml) in a Kontes "Duall" glass tissue grinder in 0.1*M* Tris buffer at *p*H 8. An amount of charcoal (Norite-A) equal to the weight of the flies used was added to remove inhibitors, and after 30 minutes the solution was centrifuged at 20,000*g* for 20 minutes. One milliliter of the supernatant was placed in the fluorometer cuvette with 0.02 ml of $10^{-2}M$ methylene blue and 0.05 ml of $5 \times 10^{-4}M$ 2-amino-4-hydroxypteridine. The increase in fluorescence due to the formation of isoxanthopterin was detected in a Turner model 110 fluorometer using a primary filter with principal transmission at 360, and a Turner 2A with a Farrand interference filter transmitting at 416 mμ for a secondary filter. The red eye pigment was estimated by measuring the fluorescence directly on the paper (*11*). The other compounds were estimated visually.

The locus involved in this investigation is on the right end of the X-chromosome between Beadex wing (Bx^s) and suppressor of forked bristle (*su-f*) (*12*). The mutants are *ma-l*, induced by x-rays by Oliver (*7*), and the bronzy allele of maroon-like eye color ($ma\text{-}l^{bz}$), originally called bronzy by M. O. Fahmy, who induced it with phenylalanine mustard (*13*). The "allelism" of these mutants is based on their biochemical similarity, on the lack of complete complementation, and on the fact that no crossovers were observed in approximately 5000 progeny (*12*). This number is low, however, and does not rule out the possibility that these mutants are psuedoallelic; indeed, because they are complementary one might expect

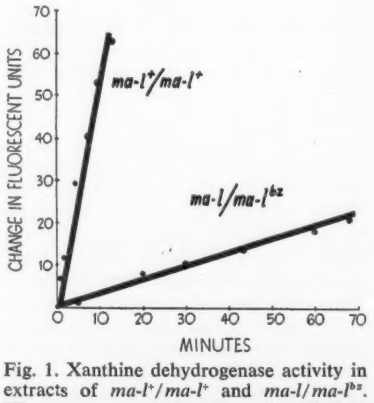

Fig. 1. Xanthine dehydrogenase activity in extracts of $ma\text{-}l^{+}/ma\text{-}l^{+}$ and $ma\text{-}l/ma\text{-}l^{bz}$. The assay was conducted as described in the text. It should be noted that no activity was detected in *ma-l* or $ma\text{-}l^{bz}$ flies.

that they will eventually be shown to cross over with each other.

The stocks used were vermilion eye color (*v*), forked bristle (*f*) *Bx*^{s} *ma-l*, which was made from the *ma-l* strain at the California Institute of Technology, and *v* *ma-l*^{bz}, made from the bronzy (*bz*) stock kindly made available by Fahmy. The eye color of these stocks is yellow-orange; the presence of *v* facilitates their separation from the complementing flies (*v f Bx*^{s} *ma-l*/*v* *ma-l*^{bz}) which have a bright red eye color. The wild-type stock used was an Oregon-R stock originally derived from the strain kept at Johns Hopkins University.

The results indicate that the phenotypes of *ma-l* and *ma-l*^{bz} are similar (*12*). Both mutants have a diminution of the red pteridine components of the eye color and our investigation reveals that *ma-l*^{bz}, like *ma-l*, is deficient in xanthine dehydrogenase. There is a consequent absence of the enzyme's reaction products, while the enzyme's substrates accumulate. Both mutants are nonautonomous (*14*), and we have been able to show that both are maternally affected if their female parent contains *ma-l*$^{+}$ (*15*). However, it is of interest that neither *ma-l* nor *ma-l*^{bz} is maternally affected if the mother was *ma-l*/*ma-l*^{bz}, a fact which indicates a functional relationship between these genes.

On the other hand, we find that females heterozygous for both genes (*ma-l*/*ma-l*^{bz}) have a normal eye color, indicating that the functional deficiencies of *ma-l* are not identical with those of *ma-l*^{bz}, and that one mutant can complement the functional losses of the other (*13*). This complementation, however, is not complete, since the amount of xanthine dehydrogenase present in *ma-l*/*ma-l*^{bz} flies is only approximately 5 percent of that of the wild-type (Fig. 1); this small amount of enzyme is reflected by low amounts of uric acid and isoxanthopterin (the enzyme products) which we observe on paper chromatograms. The low enzyme level is further reflected in the fact that hypoxanthine, which is usually present in only trace amounts in wild-type flies, accumulates in *ma-l*/*ma-l*^{bz} flies.

Other workers have also reported that the levels of enzyme found in complements are much lower than that found in the wild type (*4*, *5*). The general picture found in *ma-l*/*ma-l*^{bz} flies resembles that found in maternally affected *ma-l* males in which relatively small amounts of enzyme restore the normal eye pigmentation while only a small effect is observed on the rest of the biochemicals involved (*15*). Why this should occur is not understood, since we do not know the reactions which lead to the formation of the red pigment. Nor do we understand the mechanism behind the complementation phenomenon, which presumably occurs as a "recombination of parts" of either the template or of the enzyme. Woodward (*16*) has reported in vitro complementation when mycelial extracts of mutants which give in vivo complementation are mixed, but attempts to repeat this with our system have been negative thus far (*17*).

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6. The symbols used in this paper are as follows [based on (*7*)]: *Bx*^{s}, Beadex wing; *f*, forked bristle; *ma-l*, maroon-like eye color; *ma-l*^{bz}, bronzy allele of maroon-like; *ma-l*$^{+}$, the wild-type allele of *ma-l*; *ry*, rosy eye color; *su-f*, suppressor of forked bristle; *v*, vermillion eye color.
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17. Part of this research was carried out in the Zoological Institute of the University of Zurich while one of us (E. G.) was a postdoctoral fellow of the National Institutes of Health. We would like to thank Prof. Hadorn, Prof. Chen, Prof. Burla, Dr. Ursprung, and Dr. Anders for their kindness and help.

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Analysis of Firing Patterns in Single Neurons

Abstract. The use of a high-speed digital computer for investigation of neural firing patterns is described. The high sensitivity of the method permits detection of stimulus-response relations buried in a background of spontaneous activity.

The firing pattern of a neuron in a sensory system is generally more complex than a simple all-or-none response that occurs shortly after the delivery of a stimulus. Frequently, neurons exhibit spontaneous firings, and the change of a stimulus parameter may simultaneously affect (i) the total firing rate and its distribution in time, (ii) the interspike intervals, and (iii) the latency between the stimulus and the first spike of a burst. Visual inspection of oscilloscopic displays is most appropriate for the detection of type (iii) pattern changes. The observer who relies on such limited response criteria selects a biased sample from the total population of neurons available for observation. A more representative sampling of the population can be obtained by broadening the response criteria with a more quantitative description of the total firing patterns.

Compilation of such results from single-unit data has usually involved tedious "hand and eye" measurement of strip-film records (*1*), although some schemes have been developed for automatic display of the repetition of very constant and simple patterns of firing (*2*). In the present study the TX-O (*3*), a fast, general-purpose digital computer with a flexible input-output system, was used for the analysis of more complex firing patterns.

The TX-O computer was programed to perform two complementary analyses of tape-recorded data. The results are presented as two displays: (i) a time histogram—a histogram of the distribution of action potentials in time relative to the instant of stimulus presentation (summed over many stimulus presentations), and (ii) an interval histogram—a histogram of the occurrence of various interspike intervals (that is, time intervals that separate two successive action potentials). A peak on a time histogram shows preferred time of firing relative to the stimulus; a peak on an interval histogram shows a preferred interval between firings.

Note that both of these analyses involve time averages and therefore yield a time average of the firing pattern rather than single sequences of unit events in the pattern. The second form of analysis, the interval histogram, is mathematically similar to the autocorrelation function for a time function that is a train of pulses. Thus a Fourier transform of the smoothed interval histogram is related to a power spectrum (power as a function of frequency) of the trains of the cell firings. (It would be interesting to examine the order in which the "bins" in each of the two histograms are filled. Unfortunately, the relatively small number of events that can be observed in an experiment of reasonable length makes these fractional analyses statistically impractical.)

In our processing system, neuronal spikes and stimulus pulses from tape are picked out by discriminators and

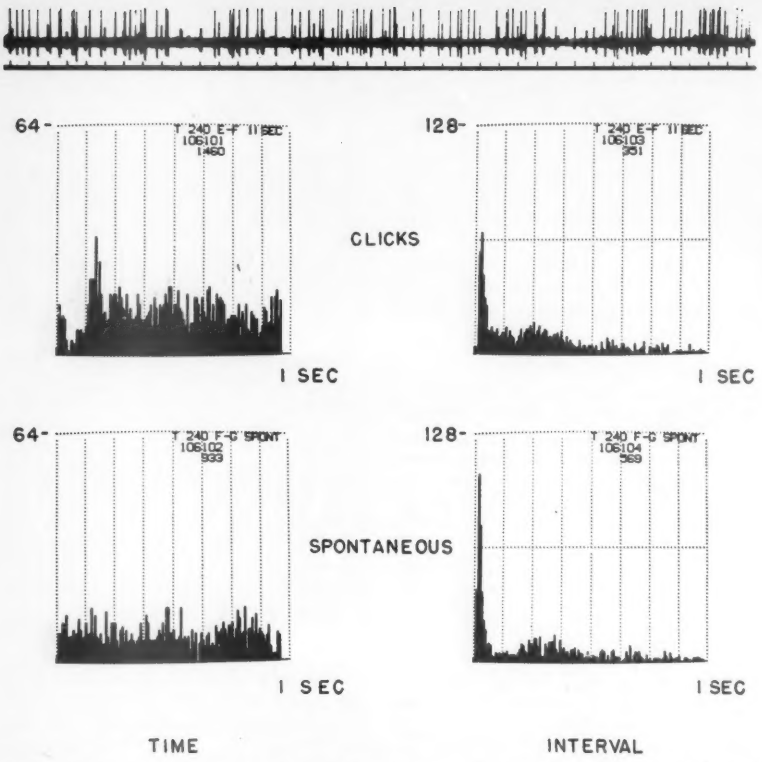

Fig. 1. Top trace, film strip of a cell's firing pattern. Lower trace, stimulus markers at 1 sec intervals. Below: time (left) and interval (right) histograms for 10 minutes of data from this unit. The stimulus condition is indicated at the upper right of each histogram (bin width, 8 msec).

Schmitt triggers, formed into standard TX-O computer pulses (by DEC digital test units), and fed directly into an available register of the computer. Detailed analog-digital conversion of the data waveforms is not used. The TX-O program senses the proper portion of the stimulus pattern, keeps internal time, and compiles the necessary histograms. The output of the processing program is a display of a histogram with various typewriter-controlled titling provisions; the display is photographed with a Polaroid camera. All relevant constants of the computation are available to the operator on toggle switches. The maximum resolution available in real processing time is 0.5 msec per bin. Better effective resolution can be obtained by playing back the data tape more slowly than it was recorded. If coarser resolution is used, the tape can be played back faster than it was recorded, and the processing time shortened.

The computer program accommodates tape-recorded experiments that involve repeated (cyclic) presentation of several different stimulus conditions. Each condition lasts for an arbitrary length of time and comprises an arbitrary number of repetitions of a basic stimulus. Such an experimental format allows meaningful comparison of the various stimulus conditions because data for all stimulus conditions are similarly affected by physiological changes of state of the preparation.

This processing system has been applied in a study of the firing patterns of single cells in the auditory cortex of lightly anesthetized cats (Nembutal). Single-neuron and slow-wave activity were observed by standard methods with 5 to 10 μ tungsten microelectrodes. In order to minimize the pulsatile motion of the brain the electrodes were moved in a closed oil-filled chamber threaded into the skull (*4*). Acoustic clicks were presented to the preparation in a repeating pattern of 15 seconds of stimulation followed by 15 seconds of silence. Both the electrical activity and the stimulus pattern were recorded with an FM tape system for later processing.

Results obtained for a cortical cell of a frequently encountered type are shown in Fig. 1. At the top is an ordinary strip-film presentation of the cell firing. The large pulses on the upper trace indicate firing of the neuron under study; the lower trace shows stimulus markers at 1 sec intervals. Below are time and interval histogram analyses of about 10 minutes of such data, for both the stimulated and spontaneous conditions. The time histograms show clearly that the cell's firings are depressed for approximately 150 msec after the delivery of the stimulus and then briefly enhanced. The interval histograms show less contrast between spontaneous and stimulated conditions. However, we note the distribution of interspike intervals is more uniform during stimulation. Since the cell is firing only about three times per second, it is extremely hard to "see" any of this behavior on the strip film.

Obvious extensions of these data-handling methods can lead to techniques that will be useful in investigating the complex relations between graded and discrete aspects of electrocortical function (*5*).

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* Postdoctoral fellow of the National Institute of Neurological Diseases and Blindness.

11 May 1960

Vivax-Type Malaria Parasite of Macaques Transmissible to Man

Abstract. Transmission of *Plasmodium cynomolgi bastianellii* from rhesus monkeys to two human subjects by *Anopheles freeborni* and the occurrence of attacks of malaria in two other laboratory workers not exposed to human malaria suggests the existence of an animal reservoir of infection complicating malaria control and eradication.

Plasmodium cynomolgi subspecies *bastianellii* was recently described by Garnham (*1*), who found distinct morphological and immunological differences between it and typical *P. cynomolgi*. The new subspecies was isolated from a *Macara irus* monkey from Malaya (*1, 2*). Garnham sent this parasite to us for study, and we have done many experiments with it in rhesus

monkeys (*Macaca mulatta*). We have seen the differences described by Garnham between this subspecies and typical *cynomolgi*.

During a period in which very large scale inoculations of monkeys with sporozoites were being carried out, two of our staff members (D.E.E. and N.C.O.) developed illness with fever which, after a remittent period, proved to have a tertian periodicity. *Vivax*-type parasites with enlarged erythrocytes and Schüffner's stippling were found in both individuals. Smears were made on new slides, stained in clean dishes with new stain. Presumably the source of the malaria was mosquitoes infected with monkey malaria, as neither individual had had any recent contact with human malarias.

Five milliliters of blood from D.E.E. were injected intravenously into an uninfected rhesus monkey (W633). Eight days later parasites were present, and a typical *cynomolgi*-type infection ensued in which parasite densities of several hundred thousand per cubic millimeter were attained. Five milliliters of blood from N.C.O. were injected intravenously into another uninfected rhesus monkey (W673). Parasites were patent on the 10th day, and a normal infection ensued.

Two inmate volunteers were each given 10 ml of blood intravenously from N.C.O. Each of these subjects developed clinical attacks of malaria, but neither one exhibited high parasite densities. The parasites were *vivax* type with enlarged erythrocytes and Schüffner's stippling. These infections are still under study.

Both D.E.E. and N.C.O. received chloroquine treatment within 24 hours after diagnosis. D.E.E. had one severe paroxysm a few hours after treatment was initiated; N.C.O. was treated the morning after a paroxysm and had no further fever. Parasites were promptly cleared in each instance, and neither patient has relapsed, to date. Parasitemia levels of both patients were low at the time of treatment (50 parasites or less per cubic millimeter).

Another staff member, H.A., allowed 30 to 50 *Anopheles freeborni* mosquitoes heavily infected with *Plasmodium cynomolgi* subspecies *bastianellii* to feed on him. Eleven and 12 days later he experienced headaches and a general feeling of malaise, and his temperature rose to approximately 100°F. When parasites could not be demonstrated, 10 ml of his blood was injected intravenously into an uninfected monkey. Parasites were demonstrable in this animal 6 days later, proving a subpatent infection in H.A.

A second staff member, C.S.S., allowed himself to be bitten by ten *Anopheles freeborni* heavily infected with *P. cynomolgi bastianellii*. Fourteen days later he experienced a typical malaria paroxysm, and *vivax*-type parasites were easily demonstrable. Treatment with chloroquine was initiated shortly thereafter.

Although circumstances indicated clearly that the malaria in question was *Plasmodium cynomolgi bastianellii*, cross-immunity studies were made. Two monkeys which had spontaneously recovered from infections with this parasite were inoculated with 400 million parasites each from monkey W633, which had received parasitized blood from D.E.E. One of the monkeys showed a transient parasitemia reaching a peak density of 1004 per cubic millimeter indicating nearly complete immunity. The other showed an infection which attained a peak parasite density of 84,800 per cubic millimeter, but the attack was shorter and less severe than the usual *bastianellii* attack. Cross-immunity studies thus supported the belief that the human infections were due to *P. cynomolgi bastianellii*.

The mode of infection of the patients accidentally infected must certainly have been by mosquito bite. Both persons were dealing closely with heavily infected mosquitoes, and it must be acknowledged that the mosquitoes were not being handled with the care and respect accorded mosquitoes infected with known human malarias. The development of the subpatent infection in H.A. and the unmistakable attack, with easily demonstrable parasites, in C.S.S. demonstrated that human malaria can arise from sporozoites of *P. cynomolgi bastianellii*.

Prior to the observations reported here it was known that *Plasmodium knowlesi* is transmissible to man by blood inoculation. This was first established by Knowles and Das Gupta (*3*) and has been confirmed a number of times. *Plasmodium knowlesi* exhibits a quotidian periodicity, and the parasite is morphologically quite dissimilar to the *vivax* type.

The only other successful transmission of a lower-monkey malaria to man known to us was that carried out by Ionescu-Mihaiesti *et al.* (*4*), who transmitted a malaria parasite of the African baboon *Papio babuin* to man and then to *Macaca mulatta*, using infected blood. No full morphological description of the parasite was given, but Ionescu-Mihaiesti *et al.* believed it to resemble *Plasmodium inui*. Sinton *et al.* (*5*) believed this parasite to be more similar to *P. gonderi*, but Rodhain and van der Berghe (*6*) believed it to be a distinct species. The strain was not maintained, due to a shortage of monkeys.

Two unsuccessful efforts have been made to transmit typical *Plasmodium cynomolgi* to man. Sinton *et al.* (*5*) used infected mosquitoes and blood in one patient with general paresis and infected mosquitoes in another. Neither showed any evidence of infection. Coggeshall (*7*), using infected blood and sporozoites, also failed in four attempts to infect patients.

The existence of a *vivax*-type parasite of lower monkeys transmissible to man may have important epidemiological implications. This observation, taken with others, indicates that primate malarias may not have such strict host specificity as is commonly supposed. Particularly significant in the present study is the fact that human infections were induced by sporozoites. Previous human infections with lower-monkey malarias were induced by means of infected blood, so it was not clear whether the human liver would support the preerythrocytic stages.

We believe that research on lower-monkey malarias, with particular regard to the possible existence of reservoirs of human infection, or sources of reinfection of man with new strains, is necessary as an essential adjunct to the present malaria eradication program.

Note added in proof: After this report was submitted for publication we learned from Leon Schmidt, director of the Christ Hospital Institute for Medical Research, Cincinnati, Ohio, that one of his staff members (R.G.) had experienced an attack of malaria shortly after the second accidental infection was diagnosed at the Memphis laboratory. Parasitized blood from the Christ Hospital patient produced a typical *cynomolgi*-type infection in a rhesus monkey. Typical *Plasmodium cynomolgi* and the subspecies *bastianellii* are present in the Cincinnati laboratory.

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7 June 1960

Telemetering of Intraenteric Pressure in Man by an Externally Energized Wireless Capsule

Abstract. Gastrointestinal intraluminal pressures have been recorded in eight patients by a pressure-sensitive telemetering capsule energized by an external, wireless source. The capsule is smaller and simpler than a battery-powered capsule, and has a relatively unlimited life. The pressure records are similar to those obtained by other sensing devices.

Pressure-sensitive radiotelemetering capsules have been designed to record intraluminal gastrointestinal pressures (*1*). Studies have demonstrated that such a capsule, within the esophagus, stomach, small intestine, or colon, will detect physiologic pressure variations and permit permanent recording (*2*). The initial telemetering studies suggested possible improvements in the original capsule design. The diameter of 1 cm and the operating life of 8 to 30 hours were not ideal. Efforts centered on a capsule to be energized by an external wireless source.

The capsule and system described here were designed and built by the Radio Corporation of America (*3*). The capsule consists of a rigid, plastic cylinder, 0.7 cm in diameter and 2.5 cm in length, enclosing a coil, capacitor, and transducer of a ferrite armature attached to a diaphragm. After the capsule is ingested, an external coil is placed around the patient. A high-frequency signal is delivered intermittently to the capsule through this external coil. Intraluminal pressure on the capsule diaphragm modulates the frequency at which the capsule circuit "rings" in response to this signal. The modulated signal is detected by the external coil and rectified, and a pressure curve is recorded (Fig. 1).

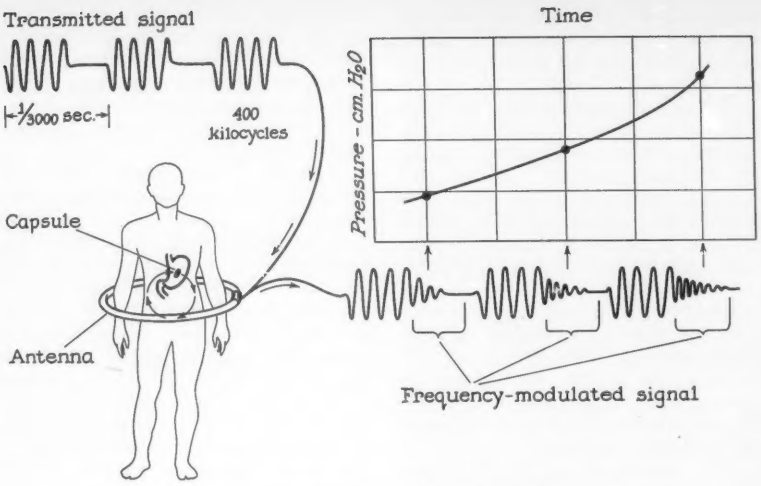

Fig. 1. Diagram of operation of the telemetering capsule.

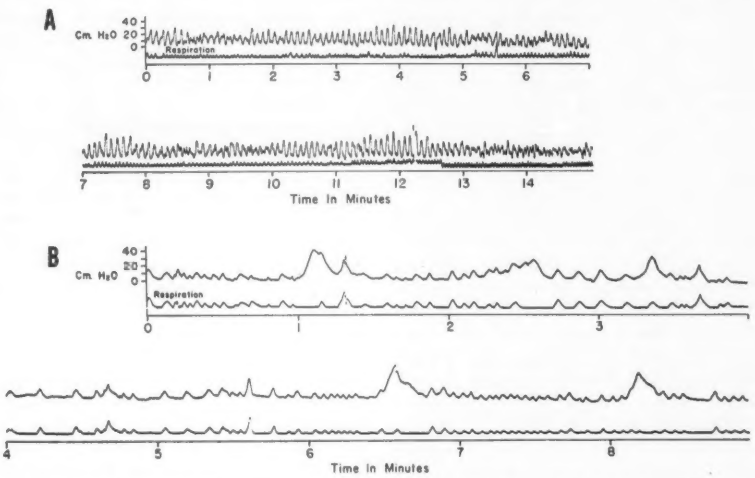

Fig. 2. Intraluminal pressure in the small intestine (*A*) and right colon (*B*).

This telemetering capsule has been employed to detect and record the intraluminal pressures of the gastrointestinal tract in eight subjects. Records were obtained from the stomach, small intestine, and colon. The patterns observed are similar to those recorded by a battery-powered radiotelemetering capsule (*2*), but the base line is more stable. An example of a record from the small intestine is shown in Fig. 2*A*. The regular wave forms, noted to occur at a rate of 11 to 12 per minute, correspond to the most characteristic type of motor patterns recorded from the small intestine. The colonic pressure record (Fig. 2*B*) shows the simple, intermittent pressure waves we have noted previously in normal patients.

This pressure-telemetering system possesses definite advantages over the initial, battery-powered, radiotelemetering capsule. It is smaller and less dense, and presumably moves more freely in the gastrointestinal tract. Since its energy is supplied from an external source, the capsule has a relatively unlimited life. Finally, the capsule is only very slightly affected by moderate changes in temperature. However, the present system is not yet ideal. The angle of coupling between the capsule and antenna is quite critical. To obtain satisfactory intraluminal pressure records in several subjects required that the subjects assume positions in relation to the antenna which were uncomfortable and probably not conducive to the recording of normal, undisturbed intestinal motility. Omnidirectional antenna systems are being developed.

The simplicity of the capsule and its effective life suggest that this system has significant potential value not only in the study of the gastrointestinal tract but in the detection and transmission of other physiologic information from different organ systems in man and animals.

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Letters

Scientists and Responsibility

Science deserves the gratitude of scientific men of good will everywhere for publishing Bertrand Russell's magnificent little speech, "The social responsibilities of scientists" [**131,** 391 (1960)]. Russell's message is as old as the problem with which he deals, but never before in human history has the need for saying it been more acute. Let us hope it is heard widely, "loud and clear."

Every scientist has to make a living and, if he is to pursue a scientific career, must have the wherewithal in equipment, money, and freedom to carry out his work. Increasingly, however, he is faced with an ever-narrower orbit of choice of problems to be investigated and scope and emphasis of investigation. Rewards of wealth and position for "popular" or "approved" research in terms of policy needs of government and industry burgeon in tantalizing proportion as rewards for "unpopular" or "disapproved" or "impractical" research shrink alarmingly. The university, traditional stronghold of scientific freedom, becomes almost pervasively dependent upon the largess of government and industry for research funds already earmarked for official or business purposes.

We in the social and behavioral sciences, though not often involved directly in the mad marathon of devising an ever more horrendous armamentarium, also bear responsibility for the consequences of our works. Had we not known this before, the scathing rebukes of a C. Wright Mills should have made it apparent (though self-conscious contentiousness tends to dilute the effectiveness of his argument). Like the physical scientists we are engaged in large numbers in research on "applied"—or what some of us term "action"—problems, in which funds are supplied by government and industry or by foundations geared often to similar objectives. Many of us find satisfaction in being able to use our skills in efforts which we hope will alleviate or change some area or aspect of a painful human condition. Simultaneously we may be subject to pressures, however delicately subtle, to orient data collection and findings in the direction of enhancement of, say, the institution or organization in which the investigation occurs. Thus, strong and persistent effort is required to maintain scientific integrity and insure that *all* results will see the light of day, and not alone those which confirm existing policies.

While sporadic symposia have occurred in the past (and frequently in such groups as the Society for Applied

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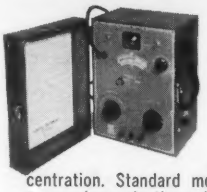

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Anthropology), I urgently propose that each of the professional organizations and academies in the social sciences enter the subject of scientific social responsibility for rounded and open discussion in its meetings and journals.

DAVID LANDY

223 Grant Avenue,
Newton Centre, Massachusetts

Physics has not always been an important profession. What we seem to find important is some knowledge of ourselves in relation to whatever and whoever interacts with us most strongly, rather than knowledge of the simpler and more remote world which physics describes. Even the practical results of physics, while historically pertinent, have seldom been a dominant factor in men's lives. When a physicist, in the past, had to decide on a job, his decision was of concern mainly to himself. Others, including military leaders, were not too strongly affected, either practically or otherwise. They had worse worries.

This is no longer so, of course. We do not know whether a nuclear war would essentially destroy the human race, or whether it would appear to our descendants as harmless compared to what they could perpetrate. We do know that millions of men and women may suffer and die owing to the work of our hands and minds.

If nuclear armaments clearly led to nuclear war, the moral choice would lie between wholesale death and destruction, on the one hand, and whatever these items may purchase on the other. That choice seems clear: working on nuclear armaments would be immoral. We could then note that armament races, in the past, have always led to war, and thus consider the moral question of what to work on as solved.

This is not a valid conclusion, however: everything in the past has led to wars—armament races, *pax Britannica*'s and disarmament treaties alike. We have wound up fighting each other whenever some greater force has not prevented us. Now, there is no way to decide whether the fear of nuclear armaments has prevented a third world war up to now. Neither can we foretell whether the balance of terror induced by nuclear armaments will provide the pressure needed to force us into a world organization which can effectively prevent war. Since we do not know the answer to these questions, we cannot take some guess and make it serve as the basis for a moral decision. All we know is that nuclear weapons exist, and, whether the terror is balanced or not, there is certainly plenty of it to go around. What should we do then?

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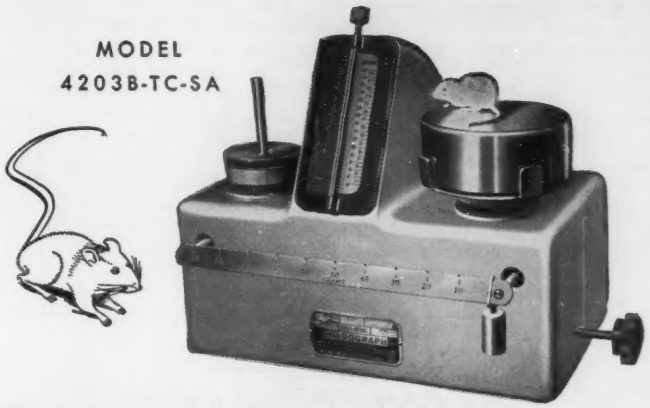

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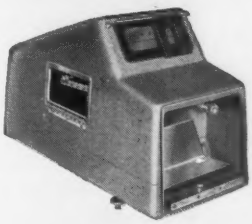

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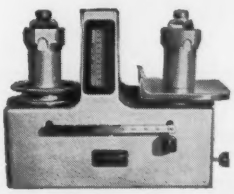

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be kept alive and in force if courage and generosity are forthcoming from some of those concerned. We can, therefore, work to the end of increasing these qualities, along with all men. We have a special incentive to do so: if world war does come, it will indeed be better for physicists if they had never been born. That will be their own opinion as well as most everyone else's! The very possibility makes us wish "not to learn war any more," in the phrase of Fox's celebrated statement to Charles II, and to turn to morally safer pursuits.

We can use our special knowledge to make the consequences of war as clear as possible. We can advise framers of agreements and makers of policy concerning the technical pitfalls that we know about, so that the agreements and policies will not fail through any ignorance or conceit of ours.

But none of this is physics. Doing these things does not answer the question, Shall we work on armaments? What jobs shall we do?

I am not sure that it is showing social responsibility for all of us to turn away, in our work, from what we have done, as being too horrible to contemplate. The real hope is that our maturity in knowing and dealing with each other can grow to match our maturity in knowing and dealing with the rest of our environment. This hope is a forlorn one if we try to force the match by burying nuclear tests, or by forgetting or even failing to explore some areas of our knowledge. We will not become more mature that way.

We have to build institutions strong enough to withstand all the pressures for war which exist now and which will become worse if we allow ourselves to forget the fireballs and what they can do. Such institutions do not come about easily. They may not come without war. They will not come at all, or, if they come, they will not last, if we simply destroy our current worst weapons and hope for the best.

Under these circumstances, in what way does it help for physicists to quit working on the physics of nuclear armaments? Surely we are not so conceited as to believe that our well-intentioned admonitions will succeed where the awesome results of our work would fail.

These are questions which I have not been able to answer and concerning which Bertrand Russell's advice would be most welcome.

MICHAEL M. MAY
E. H. Plesset Associates, Inc.,
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Bertrand Russell's article will be long remembered as a classic of rationalization. Russell states that scientists must concern themselves with the uses that society makes of scientific discoveries. In the case of "pure" science, that is manifestly impossible. We have been teaching scientists that it is impossible to foresee the future applications of their pure research and unwise to concern themselves with them. Now, says Russell, we should condemn Rutherford for his investigations of the structure of matter and Einstein for his equation on the relation between energy and matter because they have led to the atomic bomb. Should we not criticize Russell himself for his mathematical writings, which may have contributed something to the calculations that led to atom bombs?

Russell advises scientists to support fields of research the practical uses of which are beneficial. There are no such fields. All forms of scientific knowledge can be used for beneficial or nonbeneficial purposes according to the user's wish. Pasteur's work on fermentation might seem beneficial to some because it led to pasteurization, but to others it might seem nonbeneficial because it led to increased alcohol production and possibly to increased alcoholism.

DONALD L. MCRAE
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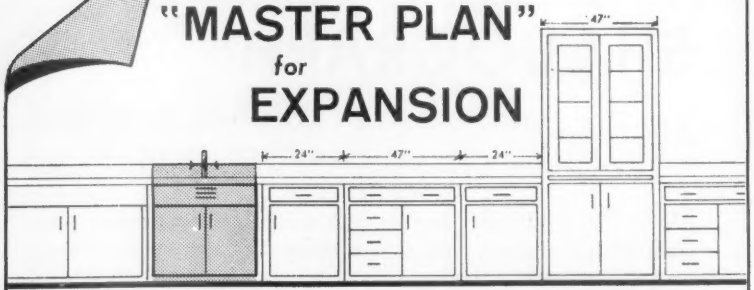

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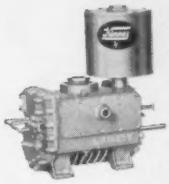

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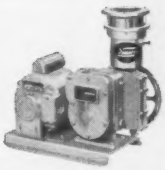

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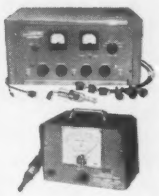

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Evolution and Modern Man

In his article "The world into which Darwin led us" [*Science* **131**, 966 (1 Apr. 1960)] George Gaylord Simpson proposes a criterion by which we can judge the validity of a hypothesis in natural science. "Perceptions that are not materially testable," he says, "or that have been contradicted by adequate tests are not rationally valid." Among valid perceptions he includes that of the truth of evolution considered as a fact, not merely as a theory. He acknowledges that "the import of the fact of evolution depends on how far evolution extends, and here there are two crucial points: does it extend from the inorganic into the organic, and does it extend from the lower animals to man?"

At these crucial points we look for a careful application of the criterion for rational validity, and we find: (i) some experts consider the experimental production of life from the nonliving as something not only materially testable but also as "imminent"; (ii) no evolutionist has seriously questioned that man did originate by evolution, although some have maintained that special principles are required to explain human origins.

In other words, the hypothesis of evolution is materially testable, and has not been contradicted by adequate tests. No claim is made that evolution, at its crucial points, has been established by adequate tests, or that it has been unambiguously observed as an accomplished fact. Nevertheless, we are expected to perceive the truth of evolution, and the fact itself is proposed as "a matter of simple rational acceptance or superstitious rejection." It takes very sharp perception, indeed, to see all this as a matter of fact, however satisfied one may be with evolution as a theory.

Furthermore, Simpson insists that, although the world certainly has purpose, and directiveness is characteristic of vital process, still these are amply explicable by natural selection. "The hypotheses of vitalism and finalism are not necessary. Everything proceeds as if they were nonexistent." The vitalism and finalism which are here rejected are not the classical principles of Aristotle, the father of biology, or of Harvey, the founder of modern biology. Both Aristotle and Harvey thought that organs such as the heart or the eye, which are normally found in certain types of animals, are inner ends or goals of embryonic development. These great naturalists reasoned that whatever happens is either by necessity, or by chance, or for a purpose. Normal organs of vision and circulation are not strictly necessary, as we know from the fact

that they are sometimes lacking, and sometimes are abnormal in structure and function. Nevertheless, they are useful instruments regularly developed in many species of animals, and so they are not by mere chance, which is haphazard. Consequently they are the ends of specialized development.

The embryo proceeds by active and orderly stages of self-development toward the perfection of the whole, and in countless cases manifestly attains it. This is the classical meaning of vitalism and finalism in regard to the individuals of concrete experience, which are the ones we know best. Any other account of these facts in teleological terms is a travesty of the classical principles of natural science. To say that everything proceeds as if these principles were nonexistent is to say what is manifestly untrue. An eye is produced by matter of a very special disposition tending actively in a definite way and in a definite environment to a definite goal. If Simpson wishes to maintain that an eye can be produced by matter which lacks an active tendency of self-development oriented toward a definite goal, he should meet the requirements of his own criterion for what is rationally valid.

WILLIAM H. KANE
Albertus Magnus Lyceum for Natural Science, River Forest, Illinois

George Gaylord Simpson's "The world into which Darwin led us" has left me rather puzzled and a bit disturbed. It was difficult to determine just what Simpson's purpose was. He seemed to be reviving the 19th-century science-religion battle, which few mature believers have difficulty with today.

Simpson seemed to say that religion has no right to claim mechanistic explanation of observable phenomena. In effect, religion should stay out of the laboratory.

What Simpson seems to misunderstand is that few modern believers in his "higher superstition" will disagree with his thesis. Religion has left the 19th century, even if only a few naturalists have. The old war is over—evolution in all its scientifically valid aspects can be worked very easily into traditional Christianity.

Yet, I still am trying to understand what Simpson was suggesting. Was it that science has finally enabled us to outgrow religion? That religion is no longer needed? The fact remains, however, that any scientist with a mature concept of and belief in the supernatural—and who understands the limitations of science—knows that science can never disprove the existence of a transcendent state.

Indeed, the day science claims ultimate explanation will be the day it

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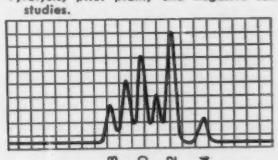

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loses its humility, and thus its vitality.

Some day I hope to hear a naturalist recommend that our lonely and pessimistic 20th-century man come to grips with what is often called his spirit. The "Dr. Simpson naturalist school" may be stressing man's responsibility to himself, but it nevertheless appears that, even though he lives in an age of self-reliance, abundance, and various brands of "freedom," modern man has become a goalless, lonely prisoner of his technosphere.

Perhaps Simpson meant that the "higher superstition" is still too much with us and must be shorn away completely. But here he would have to assume that religion (the higher superstition) has had no positive role in the shaping of our culture. This has never been shown—and, sadly, few will admit that it deserves study. Perhaps somebody besides a theologian ought to suggest bringing man's essentially spiritual nature back into harmony with his evolving, material nature—his continually greater consciousness.

WIL LEPKOWSKI
Department of Agricultural Biochemistry, Ohio State University, Columbus

Kane and Lepkowski have interestingly widened the discussion by consideration of things not actually said in my article.

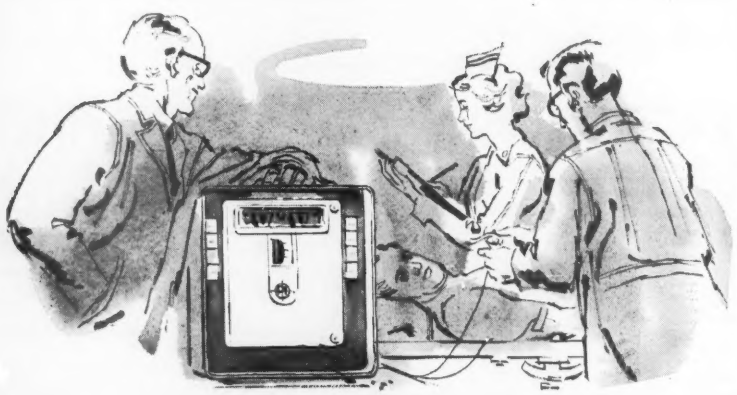
In that article I gave a criterion (obviously only one of several possible) for "perceptions . . . not rationally valid." That is not at all the same thing as a criterion for the correctness of a scientific conclusion, and the issue is obscured by Kane's assumption that they are the same, or that I thought they were. It has of course happened repeatedly that rational perceptions have been contradicted by subsequent scientific discovery. Two centuries ago it was rational for man's perception of himself to be based on the postulate of his special creation. Now it is known that the postulate was incorrect, and therefore its acceptance is no longer rational.

Kane further and even more significantly confuses the issue as to criteria for the truth of evolution. Evolution has in fact been established by adequate and positive tests, quite distinct from any negative criterion for validity of perception. I did not enumerate those tests because that was not my subject, because they are far too numerous and complex to summarize in an article, and because the more important of them are known or readily accessible to an educated American audience.

On the topics of vitalism and finalism Kane has changed the subject. I carefully defined those terms as they are understood by modern evolutionists in their relevance to phylogeny and evolution. Surely it is beside the point that Aristotle and Harvey, who of course knew nothing of evolution and whom I purposely did not mention, held different views. The obvious directiveness of individual ontogeny is another matter, one to which I did call attention and for which I mentioned the evolutionary explanation that makes vitalism and finalism (as I defined them) unnecessary hypotheses.

That, as Lepkowski puts it, "religion should stay out of the laboratory" is, on the other hand, a pertinent inference from what I actually said. It does not follow and was neither stated nor implied that all religion is incompatible with science or has no role in modern life. I expressly recognized the inability of science to solve the ultimate mystery. I also emphasized that quasi-religious concepts of vitalism and finalism (in the evolutionary, not Neo-Aristotelian, senses, please) cannot be scientifically disproved but are simply unnecessary and inappropriate in the laboratory.

Both Kane and Lepkowski are evasive as to the real point of such of my remarks as had any bearing on religion. That point is that opposition on solely religious grounds to well-attested scientific conclusions about the material universe is superstitious and impedes human progress. Evolutionists recognize that religion, in a suitably liberal sense, can be compatible with a rational, evolutionary concept of man. Lepkowski's suggestion that communicants of dogmatic religions now generally share that view is unfortunately not true. Even if other evidence were lacking, a look at my mail for a



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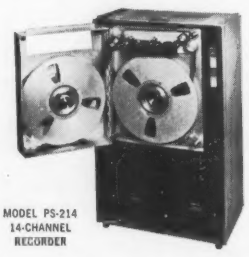

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week or two would disillusion him. A few sects, including the Roman Catholic, do conditionally permit the accommodation of evolutionary fact to official dogma. Even in those sects many pastors and most laymen nevertheless reject evolution on superstitious grounds, and it is well known that other sects forbid acceptance of this and some other facts established scientifically.

G. G. SIMPSON
Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts

Meetings

Program for Collecting Meteorites

The urgent need for a scientific program for collecting meteorites was a key topic at the 22nd meeting of the Meteoritical Society. Attended by 50 members and guests, the meeting was held at the Harvard College Observatory, Cambridge, Mass., 10 and 11 September 1959, under the auspices of the Smithsonian Institution. A symposium was conducted on the ages of meteorites and on the effects of the bombardment of meteorites by cosmic rays. During the regular sessions, participants read technical papers on the spectra of meteor trails, electron-probe microanalysis, meteorite craters, micrometeorites, cosmic dust, and tektites. Of particular importance was a conference held to discuss the critical shortage of meteoritic materials for research purposes and to outline a cooperative program to improve the situation.

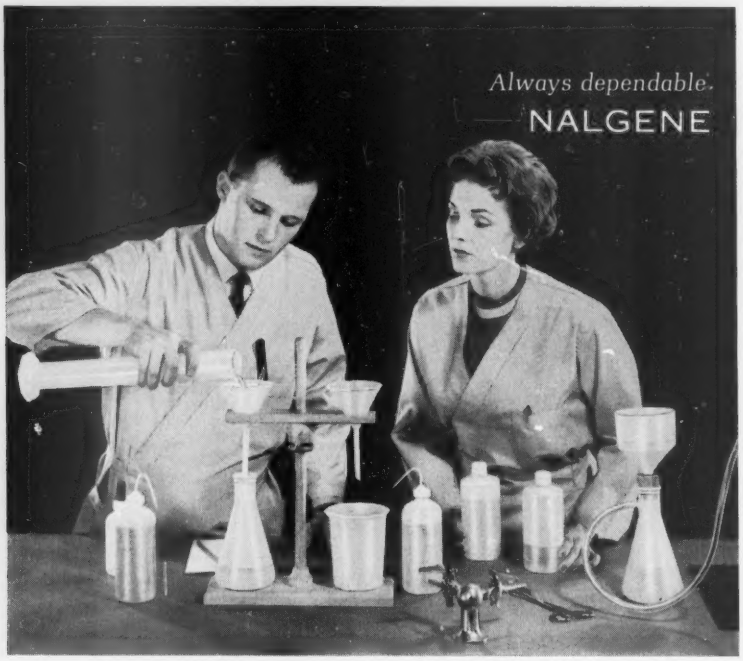
A scientist working alone can do fruitful research on meteorites if he has suitable and adequate specimens. However, the efficient collection and proper distribution of meteorite samples requires the cooperative efforts of many people.

The amount of meteoritic material available in the United States is rapidly diminishing as specimens from private and institutional collections and the meagre supply from new falls are rapidly being used up in research. Meanwhile, our need for such material is growing rapidly. At present, researchers receive samples from only about one new fall a year, an amount far less than that required for the many investigations now being carried on. As a consequence, some important research cannot be undertaken, and some investigations presently under way are starved for material.

Importance of Meteoritic Research

Results important both to astrophysics and to our national space program have been obtained from the study of the chemical, metallurgical, and mineral composition of meteorites and from measurements of the amounts of radioactive and stable isotopes produced in meteorites by cosmic rays. These results have contributed significantly to our knowledge of cosmic rays in the far regions of the solar system; the frequency of collisions among asteroids, comets, and cosmic dust; the history of the temperature and pressure to which meteorites have been subjected; the abundances of the chemical elements; the ages of meteorites; and the time lapse between the formation of the elements and the formation of the meteorites.

Measurements of the abundances of long-lived radioactive isotopes in meteorites tell us the average of the cosmic-ray intensity in the same region of space at different times; measurements of the abundances of short-lived radioactive isotopes tell us the intensity of cosmic rays in different regions of space. Recently, the amounts of tritium (half-life, 12.4 years), argon-37 (half-life, 34 days), argon-39 (half-life, 260 years), and chlorine-36 (half-life, 3.1 $\times 10^5$ years) produced in meteorites by cosmic-ray bombardment have been measured in a few samples. The ratio



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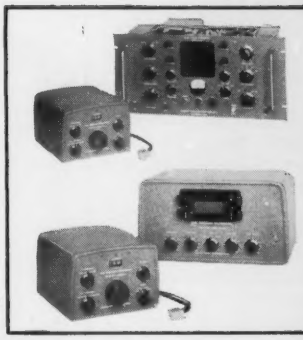

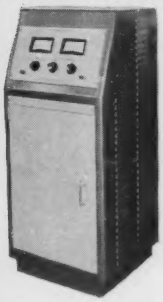

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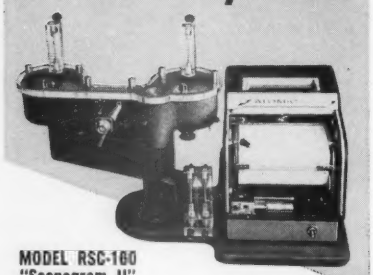

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of argon-39 to chlorine-36 indicates, when integrated over these long half-life times, that the intensity of cosmic rays is constant. However, the ratios of argon-37 to argon-39 and of tritium to argon-39 indicate, when integrated over these short half-life times, that the intensity is not always constant.

These measurements have given us information about the intensity of cosmic rays in the regions between the planets, just as in recent years rockets have provided us with data on the intensity in the region between the earth and the moon.

The amounts of the stable isotopes helium-3, helium-4, neon-20, neon-21, neon-22, argon-36, and argon-38 have also been measured in several specimens. The abundances of these isotopes in some meteorites can easily be explained by the action of cosmic rays; in others, they remain a mystery.

The length of time during which the meteorites were exposed to cosmic-ray bombardment can be derived from this study of the radioactive and stable isotopes. In some meteorites, the exposure time was as short as 10^7 years, while in others it was as long as 2×10^9 years. These data can best be explained by our assuming that collisions between interplanetary bodies have occurred at different times. However, a systematic investigation of this problem will require the experimental use of many more meteorite samples than are now available.

Metallurgical studies of iron meteorites, and studies of the diffusion of the noble gases in stony meteorites, have provided us with valuable information about the history of the pressure and temperature of these bodies. The metallurgical evidence indicates that the iron meteorites cooled very slowly under high pressures until they reached a temperature of approximately 300°C; they remained at this temperature for at least 50 million years and then became cold. On the other hand, the studies of the diffusion of the noble gases in stony meteorites indicate that these were colder than −150°C and under low pressures for almost all of their 4.5×10^9-year history. Further work is needed, however, to establish the validity, consistency, and significance of these observations.

The abundances of the nonvolatile elements in the universe are assumed to be the same as their abundances in chondritic meteorites. We therefore base our theories of the origin of these elements on a study of the chemical composition of chondrites. However, many of the measurements of these abundances which are still used as basic data were made decades ago; we should repeat them, using current laboratory techniques. We need also to investigate further the question of which elements

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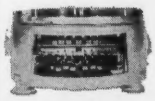

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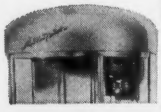

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have relatively the same abundances in all chondrites and which have not.

Perhaps even more important than the measurements of the time that a meteorite was exposed to cosmic rays are determinations of the time when it solidified, or its radiogenic age. This time is calculated from the relative amounts of a primordial parent isotope and of the stable daughter isotope. Stony meteorites have much higher concentrations of the isotopes useful for this measurement than do iron meteorites. Consequently, the radiogenic ages of the former have been measured by many investigators by several different methods; 4.5×10^9 years is the maximum value that has been obtained. Recently, the radiogenic age of several iron meteorites has been determined; the value was 10^{10} years, much higher than that for stony meteorites. This work should be repeated and extended.

The presence of isotope xenon-129 was very recently discovered in a meteorite, although a previous investigation had failed to reveal it in a sample of a different meteorite. The amount of this isotope indicates the time between the formation of the elements and the solidification of the meteorite; the value derived for this one sample was 3×10^8.

These and other investigations emphasize the critical need for an abundant supply of meteorite specimens for research purposes. Furthermore, a point often overlooked is the value of a "surplus" of samples. At present, we have so little meteoritic material to work with that every gram must be used only in a carefully planned way. A surplus would allow researchers a greater freedom in their experiments, a freedom which could lead to results that at present we cannot in any way foresee but that might be of great scientific importance.

Haphazard Collecting

The collecting of meteorites in the United States is very haphazard. No effort is made to obtain material from some reported falls; for other falls, collectors compete for the material. There is no cooperative plan for searching for finds. No extensive and continuing survey of the night sky is maintained to record the transits of meteors and determine the possibility of falls. While a few scientists and organizations have been fairly successful in obtaining specimens, there is no over-all program, and there is no well-established and generally accepted procedure.

When a meteorite falls, the owner of the property on which it lands becomes the legal owner of the material. However, he is often uncertain whether it actually is a meteorite, and he seldom knows its scientific and market value. He may take a sample to the curator of a museum or to a faculty member

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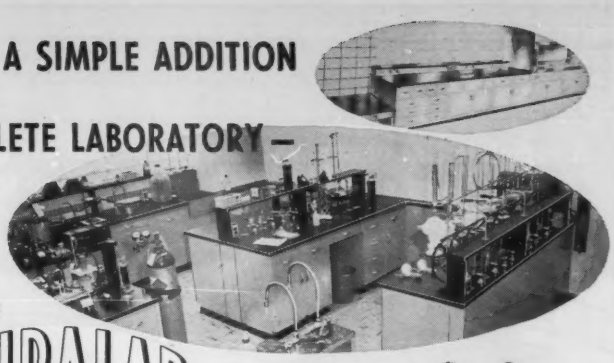

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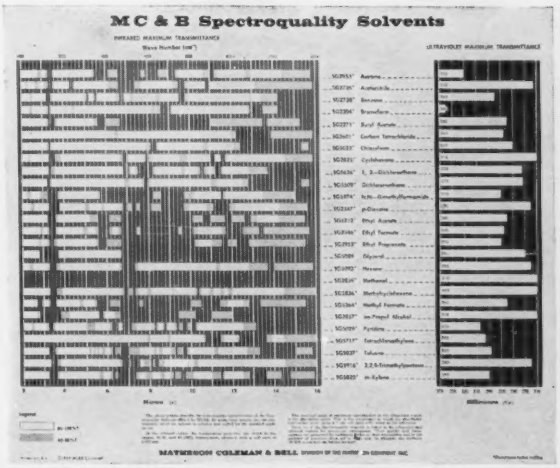

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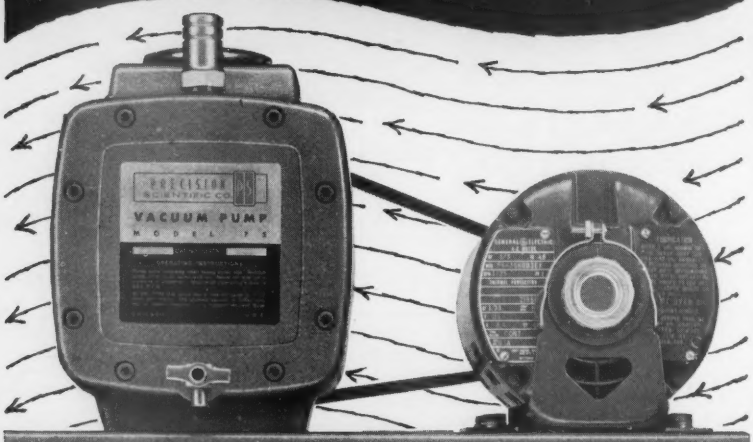

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of a local college or university. On the other hand, he may display it on the mantelpiece or store it away, give it away, or throw it away.

If considerable noise was associated with the fall, or if there was some property damage, the event may make the local newspaper and even, though rarely, a metropolitan paper. Frequently, as a consequence of this publicity the owner then asks an exorbitant price for the specimen. A few collectors will investigate such stories and attempt to obtain the meteorite; the others will not.

The personality of the successful collector is also an important factor. Some collectors readily sell or donate samples to scientists and museums; others refuse to part with any.

During the past 40 years, H. H. Nininger has been the most successful and most enlightened collector in the United States and has contributed much of the material now being used in research. Nininger is planning to retire soon.

The U.S. National Museum, the American Museum of Natural History, and the Harvard Geological Museum have also donated many samples to research. However, these museums are not at present in a position to devote much time to collecting new falls; they acquire most of their specimens through bequest or purchase from the estates of private collectors.

The result of this haphazard situation is that we obtain for research only about one new fall a year, whereas we could, through a cooperative, scientific program, acquire materials from perhaps five new falls per year. Furthermore, specimens usually do not arrive at the laboratories soon enough and in good enough condition to be of maximum value to science. For example, if we are to measure the argon-37 in a sample, we must be able to work with the sample in the laboratory within a month or two of its fall; this is seldom possible under present circumstances.

The Proposed Program

The conference at the meeting suggested three methods that would result in more efficient collecting of meteorites. First, a central agency should investigate all reported falls, actively search for meteorites, quickly purchase specimens at reasonable prices, inform interested scientists of the availability of new material, distribute samples for research, and keep accurate records. A clipping service should be used to ensure that all falls reported in the newspapers are made known to the agency. And the active support of meteorite collectors should be enlisted.

Second, amateur astronomer groups, science clubs, and the general public

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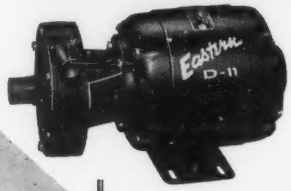

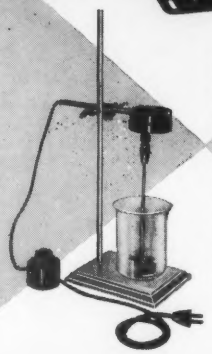

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should be alerted to the need for specimens and urged to report to the agency any bright meteors they observe. Ideally, the report should include the time of observation, the estimated magnitude of the meteor, the position at the beginning and at the end of the meteor trail relative to familiar landmarks and to background stars, and the presence or absence of any noise associated with the passage of the meteor.

Third, a network of meteor cameras should be built to photograph continuously and automatically the night sky over a large area of the United States. A realistic plan would be to have between ten and 20 wide-angle cameras stationed 100 to 200 miles apart. Periodically, the film in each camera would be processed and new film would be inserted. When the photographs show that a meteor larger than a certain size (perhaps 1 kilogram) has fallen, a search party would attempt to find the meteorite. From the photographs, the area containing the specimen would be known to within approximately 0.1 square mile.

By this means, two fields of knowledge now separated could be joined. For, associated with each collected specimen would be photographs giving its precise transit through the atmosphere, and from these data its precise orbit in space and its interactions with the atmosphere could be determined. What we thus learn from a study of the meteor trail would be correlated with what we learn from the specimen in the laboratory.

The Smithsonian Institution has agreed to serve as the central agency for this program. The Moonwatch volunteer satellite observing teams have been alerted to report falls. Any information concerning recent meteorite falls should be sent to Dr. F. L. Whipple, Director, Smithsonian Institution Astrophysical Observatory, Cambridge 38, Mass., or to Dr. E. P. Henderson, Curator of Mineralogy and Petrology, U.S. National Museum, Washington 25, D.C.

E. L. FIREMAN
Smithsonian Institution Astrophysical Observatory, Cambridge, Massachusetts

Forthcoming Events

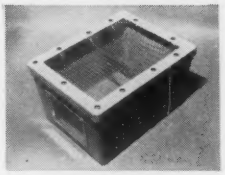
July

11–12. Response of Materials to High Velocity Deformation conf., Estes Park, Colo. (AIME, 29 W. 39 St., New York 18)

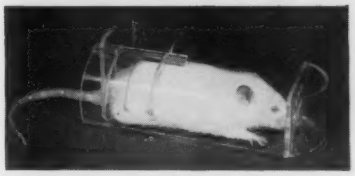
11–15. British Dental Assoc., annual, Edinburgh, Scotland. (Secretary, British Dental Assoc., 13 Hill St., Berkeley Sq., London, W.1, England)

11–15. Royal Medico-Physiological Assoc., annual, London, England. (A. B. Monro, 11 Chandos St., Cavendish Sq., London, W.1)

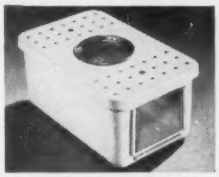
a review of recent animal care developments from econo-cage



General purpose fiberglass cage #12 with Lid 12B is 11″ x 8½″ x 6″ deep



Restraining cage #90, for immobilizing and holding rats up to 300 grams, has many applications



Mouse cage #22 with Lid 22A, of fiberglass, has four lid styles, is 11½″ x 7½″ x 5″

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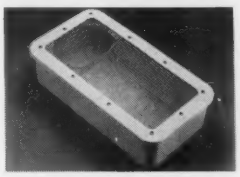
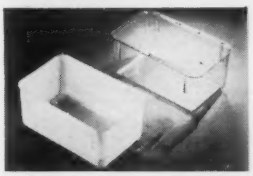


Holding and breeding cage #32, of fiberglass, is shown with Lid 32B. Cage is 19″ x 10½″ x 5⅛″



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11–16. Inter-American Nuclear Energy Commission, 2nd meeting, Petropolis, Rio de Janeiro, Brazil. (J. D. Perkinson, Jr., Inter-American Nuclear Energy Commission, c/o Pan American Union, Washington 6)

11–18. Earthquake Engineering, 2nd world conf., Tokyo and Kyoto, Japan. (K. Muto, Organizing Committee, 2nd World Conf. on Earthquake Engineering, Science Council of Japan, Ueno Park, Taito-ku, Tokyo)

11–22. Grassland Cong., 8th intern., Reading, Berks, England. (British Grassland Soc., Grassland Research Inst., Hurley, North Maidenhead, Berks)

15–22. Mycology, 6th Commonwealth conf., London, England. (Commonwealth Mycological Inst., Ferry Lane, Kew, Surrey, England)

18–22. International Conf. on Congenital Malformations, London, England. (S. E. Henwood, Intern. Medical Congress, Ltd., 120 Broadway, New York 5)

18–22. Peaceful Application of Nuclear Energy, 3rd Inter-American symp., Petropolis, Rio de Janeiro, Brazil. (J. D. Perkinson, Jr., Inter-American Nuclear Energy Commission, c/o Pan American Union, Washington 6)

18–23. Endocrinology, 1st intern. cong., Copenhagen, Denmark. (G. Pincus, 1st Intern. Cong. of Endocrinology, Worcester Foundation, Shrewsbury, Mass.)

18–25. French Assoc. for the Advancement of Science, 79th cong., Grenoble. (Association Française pour l'Avancement des Sciences, 28 rue Serpente, Paris 6°)

19–22. International Conf. on Scientific Problems of Crop Protection, Budapest, Hungary. (Z. Király, Research Inst. for Plant Protection, Budapest)

21–27. Medical Electronics, 3rd intern. conf., Olympia, London, England. (Secretary, Institution of Electrical Engineers, Savoy Pl., London, W.C.2)

23–28. Otolaryngology, 7th intern. cong., Paris, France. (H. Guillon, 6, avenue MacMahon, Paris, 17°)

24–19. Modern Physical Theories and Associated Mathematical Developments, Boulder, Colo. (K. O. Friedricks, New York Univ., 25 Waverly Pl., New York)

25–6. International Assoc. of Physical Oceanography, 13th general assembly, Helsinki, Finland. (B. Kullenberg, c/o Oceanografiska Institutet, P.O. Box 1038, Goteborg 4, Sweden)

26–28. Poliomyelitis, 5th intern, conf., Copenhagen, Denmark. (S. E. Henwood, International Poliomyelitis Congress, 120 Broadway, New York 5)

27–12. Mathematical Statistics and Probability, symp., Berkeley, Calif. (A. P. Burroughs, Air Force Office of Scientific Research, Research Information Office, AFOSR/USAF, Washington 25)

28–29. Computers and Data Processing, 7th annual symp., Estes Park, Colo. (W. H. Eichelberger, Denver Research Inst. Univ. of Denver, Denver 10, Colo.)

30–6. Institute on Religion in an Age of Science, 7th annual conf., Star Island, N.H. (R. Burhoe, American Acad. of Arts and Sciences, 280 Newton St., Brookline 46, Mass.)

31–5. Alcohol and Alcoholism, 26th intern. cong., Stockholm, Sweden. (A. Tongue, Bureau International contre l'Alcoolisme, Case Gare 49, Lausanne, Switzerland)

31–5. Photobiology, 3rd intern. cong., Copenhagen, Denmark. (A. Hollaender, Biology Div., Oak Ridge Natl. Laboratory, Oak Ridge, Tenn.)

31–6. Psychology, 16th intern. cong., Cologne, Germany. (Prof. Undeutsch, Psychology Inst. Universität, Cologne)

31–7. Anthropological and Ethnological Sciences, 6th intern. cong., Paris, France. (H. Vallis, Directeur, Musée de l'Homme, Palais de Chaillot, Place du Trocadéro, Paris 16°)

August

1–3. Global Communications, 4th symp., Washington, D.C. (R. L. Clark, c/o Office of Director of Defense Research and Engineering, Washington 25)

1–6. Esperanto Cong., 45 annual intern., Brussels, Belgium. (45-a Universala Kongreso de Esperanto, Brussels)

1–12. Modulation Theory and Systems, Cambridge, Mass. (E. J. Baghdady, Dept. of Electrical Engineering, Massachusetts Inst. of Technology, Cambridge)

2–5. Poultry Science Assoc., Davis, Calif. (C. B. Ryan, PSA, Dept. of Poultry Husbandry, Texas A & M College, College Station)

3–6. Gas Chromatography (Infrared Spectroscopy Inst.), Nashville, Tenn. (N. Fuson, Fisk Infrared Inst., Fisk Univ., Nashville 8)

3–6. Rarefied Gas Dynamics, 2nd intern. symp. (by invitation only), Berkeley, Calif. (Engineering and Science Extension, Univ. of California, 2451 Bancroft Way, Berkeley 4)

6–12. International Geographical Cong., 19th, Stockholm, Sweden. (IGC, Postfach, Stockholm 6)

7–10. American Soc. of Clinical Hypnosis, Miami, Fla. (S. Hershman, 6770 N. Lincoln Ave., Chicago 46, Ill.)

7–12. Gerontology, 5th intern. cong., San Francisco, Calif. (L. Kuplan, Intern. Cong. of Gerontology, P.O. Box 2103, Sacramento 10, Calif.)

7–13. Industrial Research Conf., Harriman, N.Y. (Miss M. F. Garvey, Industrial and Management Engineering Dept., Columbia Univ., New York 27)

8–11. American Astronautical Soc., Seattle, Wash. (R. M. Bridgforth, AAS, Propulsion Unit, Boeing Airplane Co., Aero-Space Div., P.O. Box 3707, Seattle 24)

8–12. American Inst. of Electrical Engineers, San Diego, Calif. (R. S. Gardner, AIEE, 33 W. 39 St., New York 18)

8–13. World Federation for Mental Health, 13th annual, Edinburgh, Scotland. (Secretariat, WFMH, 19 Manchester St., London, W.1, England)

8–20. American Soc. of Criminology, London, England. (D. E. J. MacNamara, New York Inst. of Criminology, 115–117 W. 42 St., New York 36)

9–13. Hail Storms, intern conf., Verona, Italy. (H. G. M. Ligpa, American Meteorological Soc., Stanford Research Inst., Stanford, Calif.)

11–13. Rocky Mountain Radiological

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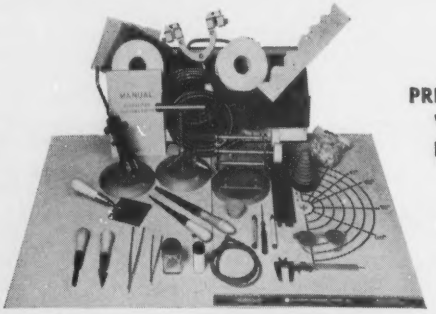

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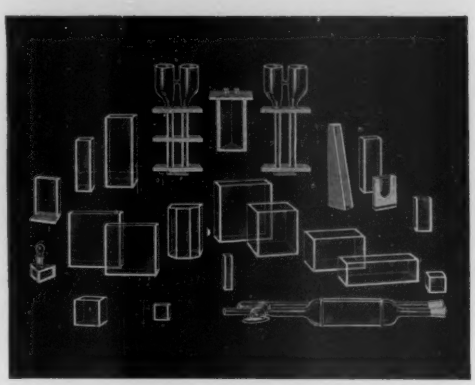

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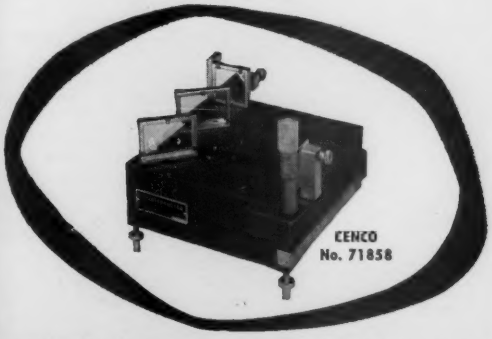

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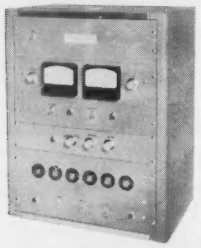

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11–16. Canadian Teachers Federation, Winnipeg, Manitoba. (G. G. Croskery, 444 MacLaren St., Ottawa 4, Ontario)

14–19. American Pharmaceutical Assoc., Washington, D.C. (R. P. Fischelis, APA, 2215 Constitution Ave., NW, Washington 7)

14–19. International Cong. of Clinical Chemistry, Edinburgh, Scotland. (S. C. Frazer, Clinical Laboratory, Royal Infirmary, Edinburgh)

14–20. Cardiology, 6th Inter-American cong., Rio de Janeiro, Brazil. (H. Alqueres, P.O. Box 1594, Rio de Janeiro)

15–16. National Assoc. of Boards of Pharmacy, Washington, D.C. (P. H. Costello, 77 W. Washington St., Chicago, Ill.)

15–17. Heat Transfer Conf., ASME and AICE, Buffalo, N.Y. (A. B. Conlin, Jr., ASME, 29 W. 39 St., New York 18)

15–17. Organic Scintillation Detectors, intern. conf., Albuquerque, N.M. (G. H. Daub, Chemistry Dept., Univ. of New Mexico, Albuquerque)

15–18. American Veterinary Medicine Assoc., Denver, Colo. (H. E. Kingman, Jr., 600 S. Michigan Ave., Chicago 5, Ill.)

15–18. Radiation Biology, 3rd Australian conf., Sydney, Australia. (P. Ilbery, Dept. of Preventive Medicine, Univ. of Sydney, New South Wales, Australia)

15–20. International Astronautical Federation, 11th cong., Stockholm, Sweden. (Secretariat, Intern. Astronautical Federation, 12, Bessborough Gardens, London, S.W.1, England)

15–23. Soil Science, 7th intern. cong., Madison, Wis. (R. Bradfield, Dept. of Agronomy, Cornell Univ., Ithaca, N.Y.)

15–24. Crystallography, intern. cong., Cambridge, England. (W. H. Taylor, Cavendish Laboratory, Cambridge, England)

15–25. Chemistry of Natural Products, IUPAC symp., Melbourne, Canberra, and Sydney, Australia. (Convener, Symposium Organizing Committee, Box 4331, G.P.O., Melbourne)

15–25. International Geological Cong., 21st session, Copenhagen, Denmark. (IGC, Mineralogical-Geological Museum, Univ. of Copenhagen, Øster Boldgade 7, Copenhagen K)

15–25. International Paleontological Union, Copenhagen, Denmark. (J. Roger, Service d'Information Geologique, B.R.G.-G.M., 74, rue de la Fedération, Paris 15e, France)

15–25. Sedimentology Cong., 6th intern., Copenhagen, Denmark. [General Secretary, IAS, c/o Institut Français du Petrole, 4, place Bir Hacheim, Rueil-Malmaison (Seine-et-Oise), France]

16–18. Biological Effects of Microwave Radiation, 4th annual conf., New York, N.Y. (M. Eisenbud, New York Univ. Post Graduate Medical School, 550 First Ave., New York 16)

16–19. Society of Automotive Engineers, San Francisco, Calif. (R. W. Crory, SAE, Meetings Operation Dept., 485 Lexington Ave., New York 17)

17–19. Hydraulics Conf., Seattle, Wash. (W. H. Wisely, American Soc. of Civil Engineers, 33 W. 39 St., New York 18)

17–19. University Nuclear Reactors,

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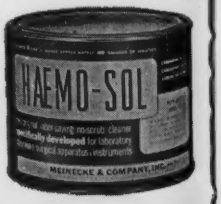

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17–21. Ionization Phenomena in Gases, 4th intern. conf., Uppsala and Stockholm, Sweden. (A. Nilsson, Fysikum, Uppsala)

20. American Inst. of Ultrasonics in Medicine, Washington, D.C. (D. M. Stillwell, Dept. of Physical Medicine and Rehabilitation, Univ. of Colorado Medical Center, Denver 20)

21–24. Latin-American Cong. of Angiology, Rio de Janeiro, Brazil. (R. C. Mayall, Caixa Postal 1822, Rio de Janeiro)

21–24. National Council of Teachers of Mathematics, Salt Lake City, Utah. (M. H. Ahrendt, 1201 16 St., NW, Washington 6)

21–25. American Soc. of Pharmacology and Experimental Therapeutics, Seattle, Wash. (H. Hodge, Dept. of Pharmacology, Univ. of Rochester, Rochester, N.Y.)

21–26. American Cong. of Physical Medicine and Rehabilitation, Washington, D.C. (Mrs. D. C. Augustin, 30 N. Michigan Ave., Chicago 2, Ill.)

21–26. Physical Medicine, 3rd intern. conf., Washington, D.C. (W. J. Zeiter, 2020 E. 93 St., Cleveland, Ohio)

21–6. Pacific Science Cong., 10th, Honolulu, Hawaii. (Secretary-General, 10th Pacific Science Cong., Bishop Museum, Honolulu 17)

22–25. American Astronomical Soc., Mexico City, Mexico. (J. A. Hynek, Smithsonian Astrophysical Observatory, 60 Garden St., Cambridge 38, Mass.)

22–25. American Physiological Soc., San Francisco, Calif. (R. G. Daggs, APS, 9650 Wisconsin Ave., NW, Washington 14)

22–26. Plasma Physics, symp., Gatlinburg, Tenn. (University Relations Div., Oak Ridge, Inst. of Nuclear Studies, P.O. Box 117, Oak Ridge, Tenn.)

22–26. Western Resources, 2nd annual conf., Boulder, Colo. (M. E. Garnsey, Dept. of Economics, Univ. of Colorado, Boulder)

23–25. Assoc. for Computing Machinery, natl., Milwaukee, Wis. (J. Moshman, ACM, Council for Economic and Industry Research, 1200 Jefferson Davis Highway, Arlington 2, Va.)

23–25. Cryogenic Engineering Conf., Boulder, Colo. (K. D. Timmerhaus, CEC, Dept. of Chemical Engineering, Univ. of Colorado, Boulder)

23–26. American Statistical Assoc., annual, Palo Alto, Calif. (D. C. Riley, ASA, Beacon Bldg., 1757 K St., NW, Washington 6)

23–26. Biological Photographic Assoc., Salt Lake City, Utah. (Miss J. H. Waters, Box 1668, Grand Central Post Office, New York 17)

23–28. American Ornithologists' Union, Ann Arbor, Mich. (H. G. Diegnan, Division of Birds, U.S. National Museum, Washington 25)

24–27. Forest Biology Conf., Seattle, Wash. (Miss E. N. Wark, Technical Assoc. of the Pulp and Paper Industry, 360 Lexington Ave., New York 17)

24–27. Internal Medicine, 6th intern. cong., Basel, Switzerland. (Secretariat, 6th ICIM, 13 Steinentorstre, Basel)

24–2. International Union for the His-

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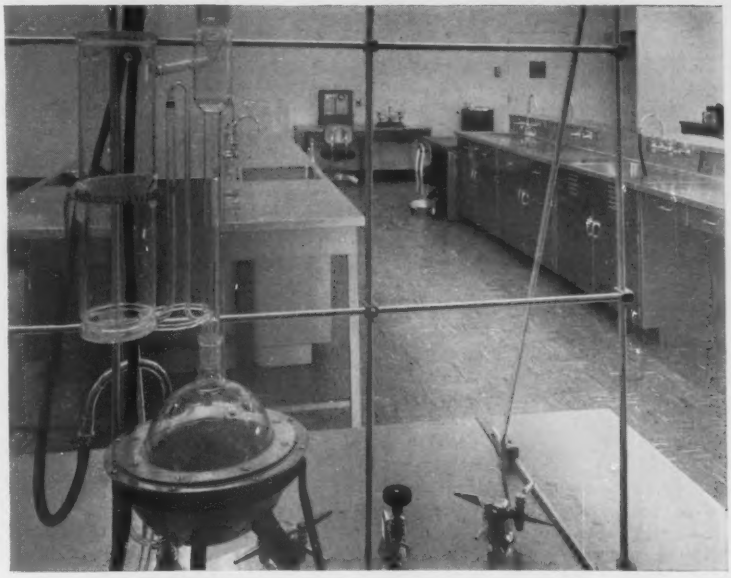

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● Linde Company manufactures a full line of containers (including the 16½ cu. ft. storage capacity LNR-640 Refrigerator), accessories and other cryogenics equipment for the storage and handling of liquefied atmospheric gases. For information on the LNR-25B Refrigerator or other equipment, mail the coupon.

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- preservation of enzymes, hormones, proteins
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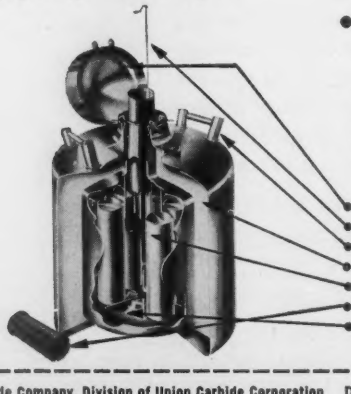

CONSTRUCTION

Cutaway shows interior arrangement of storage baskets in the LINDE LNR-25B and its construction. Baskets are easily and quickly withdrawn through wide-entrance tube. All-stainless welded construction and superior insulation make it both portable and durable.

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tory and Philosophy of Science, Stanford, Calif. (R. Taton, 64, rue Gay-Lussac, Paris 5e, France)

25–27. Chemical Organization of Cells, 2nd conf., Madison, Wis. (J. F. A. McManus, Dept. of Pathology, Univ. of Alabama Medical Center, Birmingham)

25–3. High Energy Nuclear Physics, intern. conf., Rochester, N.Y. (W. A. Jamison, Dept. of Physics and Astronomy, Univ. of Rochester, Rochester 20)

27–30. International Union of Biological Sciences, section of embryology, Pallanza, Italy. (F. E. Lehmann, Kuhnweg 10, Berne, Switzerland)

28–31. American Phytopathological Soc., Green Lake, Wis. (W. B. Hewitt, Dept. of Plant Pathology, Univ. of California, Davis)

28–31. Potato Assoc. of America, Green Lake, Wis. (R. L. Sawyer, Long Island Vegetable Research Farm, Cornell Univ., Riverhead, N.Y.)

28–31. Soil Conservation Soc. of America, Guelph, Ontario, Canada. (H. W. Pritchard, 838 Fifth Ave., Des Moines 14, Iowa)

28–1. American Inst. of Biological Sciences, annual, Norman, Okla. (H. T. Cox, AIBS, 2000 P St., NW, Washington 6)

28–1. Association of American Geographers, East Lansing, Mich. (M. F. Burrill, Office of Geography, Dept. of Interior, Washington 25)

28–1. Diseases of the Chest, intern. cong., Vienna, Austria. (M. Kornfeld, 112 E. Chestnut St., Chicago 11, Ill.)

28–2. Combustion, 8th intern. symp., Pasadena, Calif. (Office of Industrial Associates, California Inst. of Technology, Pasadena)

28–2. International Pharmaceutical Federation, Copenhagen, Denmark. (A. W. Tønnesen, Bispebjerg Hospital, Copenhagen, N.V.)

28–2. International Soc. for the Welfare of Cripples, world cong., New York, N.Y. (D. V. Wilson, 701 First Ave., New York 17)

28–3. Electron Microscopy, European regional conf., Delft, Netherlands. (A. L. Housink, Lab. v. Microbiologie, Julianalaan 67A, Delft)

28–3. Histochemistry and Cytochemistry, 1st intern. cong., Paris, France. (R. Wegmann, Institut d'Histochimie Medicale, 45, rue des Saints-Pères, Paris 6e)

29–31. American Sociological Assoc., New York, N.Y. (D. R. Young, Russell Sage Foundation, 505 Park Ave., New York)

29–31. Clinical Chemists (Canadian and American Societies), annual, Montreal, Canada. (E. Harpur, Montreal Children's Hospital, Montreal)

29–31. Electron Microscope Soc. of America, 18th annual, Milwaukee, Wis. (W. C. Bigelow, Dept. of Chemical and Metallurgical Engineering, Univ. of Michigan, Ann Arbor)

29–31. Metallurgy of Elemental and Compound Semiconductors, Boston, Mass. (E. O. Kirkendall, AIME, 29 W. 39 St., New York 18)

29–31. Water Quality Measurement and Instrumentation, PHS symp., Cincinnati, Ohio. (R. T. Hyde, Robert A. Taft Sanitary Engineering Center, 4676 Columbia Parkway, Cincinnati 26)

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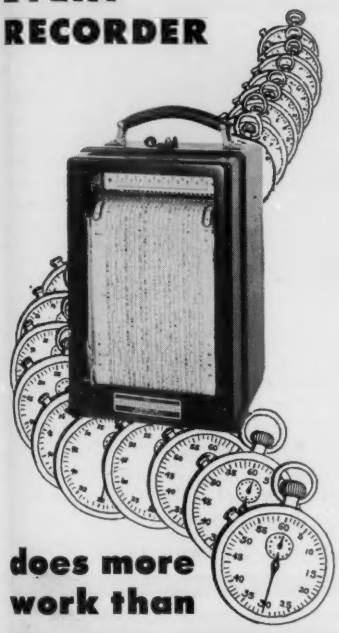

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■ DETECTION REAGENTS for amino acid and carbohydrate chromatograms are available in aerosol dispenser cans. Reagents will be available for sugar phosphates, inorganic phosphates, aliphatic acids, and keto acids. Also available are spray solutions to preserve chromatograms as permanent records (Schaar and Company, Dept. Sci589, 7300 W. Montrose Ave., Chicago 34, Ill.)

■ POWER SUPPLY for computer applications is designed to protect external circuitry by cutting off all outputs in the event the current in any output exceeds a predetermined value. The completely transistorized supply furnishes ±15 volts at 10 amp, ±6 volts at 5 amp, and 48 volts at 1 amp. Regulation for line or load is ±0.2 percent and ripple is less than 3 mv. (Invar Electronics Corp., Dept. Sci590, 323 West Washington Blvd., Pasadena, Calif.)

■ DATA ACCUMULATOR is a six-channel indicator and recorder that accepts bidirectional pulses produced by measuring devices at rates up to 15,000/sec. Each channel has a storage capacity of ±999,999 counts. Output of the system can be recorded by electric typewriter, card punch, or tape perforator. A control unit supplies output programing and related control signals. Identification and calibration data are derived from 12 front-panel dial switches. Visual readout for each channel is provided by numeral tubes. (Data Instrument Division of Telecomputing Corp., Dept. Sci591, 12838 Saticoy St., North Hollywood, Calif.)

■ CONSTANT-TEMPERATURE BLOCK maintains laboratory samples at predetermined temperature during performance of temperature-sensitive measurements. The unit, which uses cast-aluminum blocks as thermal conductors to a heat transfer bath of water or organic liquid, is adjustable to maintain any temperature between 30° and 50°C within ±0.5°C in normal environment or to ±0.2°C in an air-conditioned environment. (Beckman Scientific and Process Instruments Division, Dept. Sci592, 2500 Fullerton Rd., Fullerton, Calif.)

■ STANDARD CELL of Weston unsaturated type furnishes output voltage between 1.0190 and 1.0198 volts with drift said to be less than 3 parts per million per year. The cell is embedded with a

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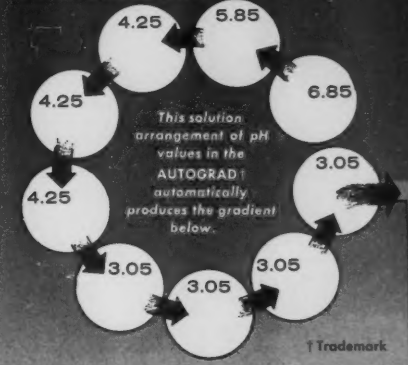

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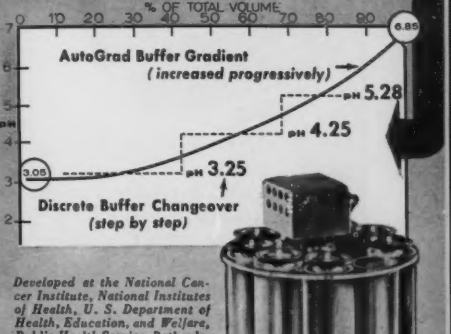

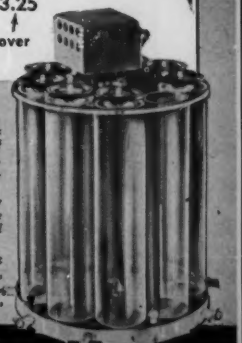

Developed at the National Cancer Institute, National Institutes of Health, U. S. Department of Health, Education, and Welfare, Public Health Service, Bethesda, Maryland.

***Procedure developed by *Karl A. Piez, National Institute of Dental Research, National Institute of Health.*

*Reference: "*Variable Gradient Device for Chromatography*", K. A. Peterson and H. A. Sober, Anal. Chem., Vol. 31, No. 34, May 1959.*

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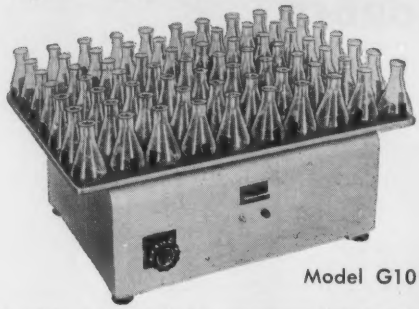

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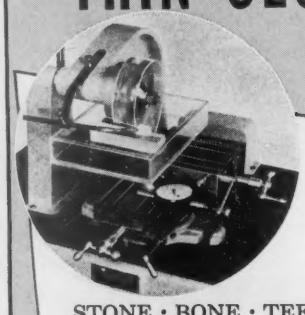

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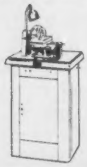

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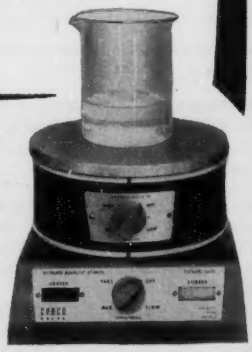

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■ DIRECT PRINTING CATHODE-RAY TUBES employ a metallic-element-mosaic target in the tube face. The metallic elements are 0.001 in. in diameter on approximately 0.004-in. centers. The cathode-ray tube electron beam, operating through the mosaic elements, produces a charge pattern on paper or other dielectric surface. The charge pattern is rendered visible by adherence of a pigment powder that may be permanently fixed in place by heat. The type L-4013 tube provides a matrix area 2.75 in. by 0.15 in. The type L-4016 has a one-dimensional array 2.75 in. long. Deflection of the electron beam accomplishes one dimension of motion, the dielectric material moving in the orthogonal direction. Writing rates of 0.1 μsec per element are said to be possible. (Litton Industries, Dept. Sci596, 960 Industrial Rd., San Carlos, Calif.)

■ DRY ELECTROMAGNETIC SEPARATOR consists of a stack of six 4-in.-diameter grids that are magnetized by a direct-current coil. The grids have sloping vanes that divide and retard the flow of material so that the material sifts through in a zigzag course. An adjustable vibrator, driven through a flexible drive, keeps the material flowing. The iron particles collected are discharged by turning of current to the coils. (S. G. Frantz Co., Inc., Dept. Sci597, 72 Kline Ave., Trenton 6, N.J.)

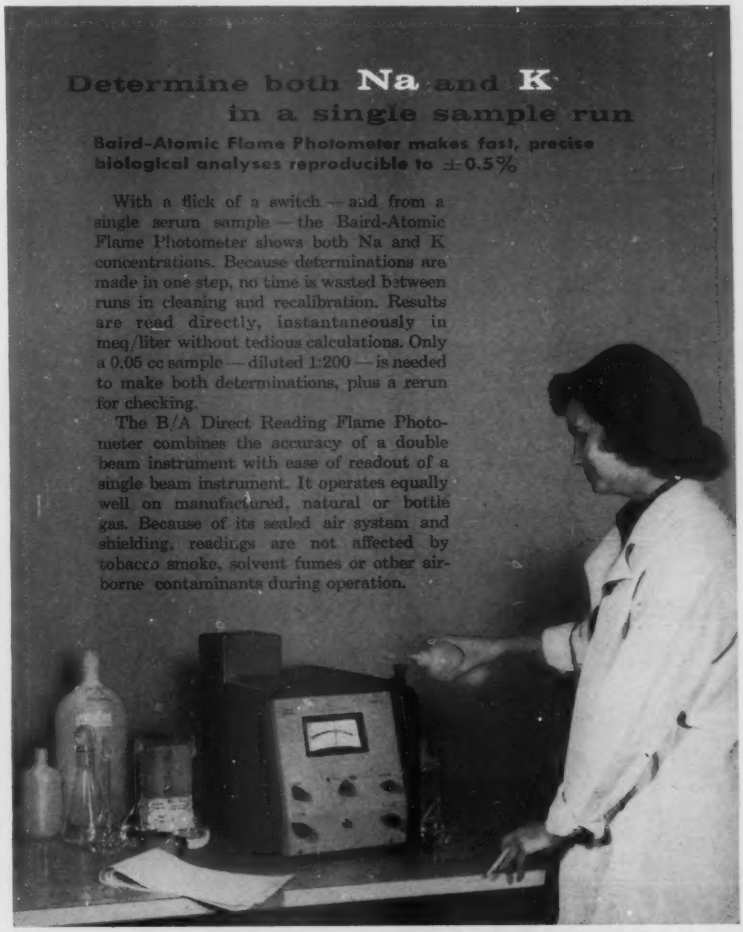
■ TENSION IMPACT TESTER for plastics and ceramics incorporates a pendulum hammer with a two-jaw gripping device that holds the specimen during the downward swing. At the moment of impact one part of the gripping device is arrested by a stop. The hammer continues its swing with the other part of the gripping device and the specimen is pulled apart. Resistance to the tensile impact force is shown on a dial. (Testing Machines, Inc., Dept. Sci598, 72 Jericho Turnpike, Mineola, N.Y.)

■ DIGITAL DISPLAY is an incandescent-lamp readout device that displays the digits 0 through 9 on a common 1-by-1 in. area. The panel-mounting units measure 1 by 1 by 3 in. Operating voltage may be 2.5, 6, 12, or 28 volts. Special units that display as many as ten complete messages in the same 1-in.^{2} viewing area are also available. (Burroughs Corporation, Dept. Sci599, P.O. Box 1226, Plainfield, N.J.)

■ CORE-MEMORY-SYSTEM TESTER is designed to locate defects automatically in coincident current systems. The tester detects and counts defective cores by reading in and reading out a pattern of information and checking for accuracy. Memory systems with planes up to 128 by 128 are accommodated. Operation may be programed to stop upon detection of an error, to determine its location, or to pause on the error and then continue the test. (Digital Equipment Corp., Dept. Sci602, Maynard, Mass.)

■ INDICATOR-TUBE DRIVER comprises ten medium-voltage NPN transistors in a common-emitter configuration with each transistor driving one of the indicator tube's ten cathodes. The device is encapsulated on a standard indicator-tube socket and is designed for direct panel mounting with over-all length 2 in. and nominal 1-in. diameter. Triggering signal can be as low as 3 volts, 300 μa. (Burroughs Corporation, Dept. Sci600, P.O. Box 1266, Plainfield, N.J.)

■ ULTRAVIOLET SPECTROPHOTOMETER is a double-beam instrument for the 220 to 770 mμ wavelength range. A vibrating-mirror assembly directs the beam alternately through the sample and reference. An output meter reads directly absorbance and percent transmission. Conversion to automatic recording can be accomplished by adding a wavelength drive and strip-chart record. Stray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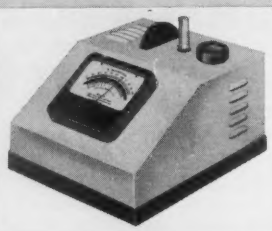

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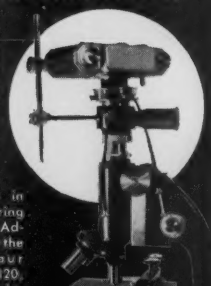

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■ TIME-DELAY GENERATOR operates in five ranges from 0.1 to 10,000 μsec. Accuracy is said to be ±1 percent and linearity tolerance ±1 percent. The unit may be triggered by a periodic wave of 15 volts peak-to-peak amplitude or an 8 volts peak negative or positive pulse of noncritical shape. Delay is presented as the time between two approximately triangular pulses with rise time less than 0.05 μsec. (B. J. Electronics, Borg-Warner Corp., Dept. Sci601, 3300 Newport Blvd., Santa Ana, Calif.)

■ FREQUENCY CONVERTER furnishes a d-c output in response to input frequency. Selection of full-scale frequency from 500 cy/sec to 100 kcy/sec is accomplished by changing a plug-in circuit board. Linearity is said to be better than 0.1 percent; drift less than ±0.1 percent from −15 to +55°C. Output signal level is ±10 volts and output impedance less than 0.25 ohm. An integral regulated power supply is provided for each channel. (Vidar Corporation, Dept. Sci603, 2107 El Camino Real, Palo Alto, Calif.)

■ VACUUM GAGE of McLeod type compresses gas in the capillary between two mercury columns, thereby avoiding difficulties arising from contamination of the closed end of a capillary. A piston is used to raise the mercury level to trap a given amount of gas for compression. The knob used to actuate the piston is threaded to permit fine adjustment of the mercury meniscus to a ring marking the compressed volume. Pressure is read directly from a calibrated manometer tube. (The Emil Greiner Co., Dept. Sci608, 20-26 N. Moore St., New York 13, N.Y.)

■ DIGITAL COMPARATORS are available in two models, one accepting two 24-bit parallel binary numbers, the other, two 24-bit parallel binary-coded-decimal numbers. By a process of digital comparison, an error-modulated 60 to 1000 cy/sec a-c output is produced with an amplitude of 23 mv per unit error for the pure-binary model and 15 mv per unit error for the binary-coded-decimal model. Saturation amplitude is 1.5 volts a-c at approximately 5 kohm impedance. (Norden Division, United Aircraft Corp., Dept. Sci611, 50 Commerce Rd., Stamford, Conn.)

■ STRAIN GAGE is a photoelectric direct-reading uniaxial strain indicator. The device indicates axial strain in the direction of gage application only. In addition to axial strain, lateral bending and torque are also indicated. Linear displacement of visible interference fringes indicates strain magnitudes. Polarizers are built in. The gages are said to be easily installed on any surface or material and may be observed visually or photographed. Two types provide gage lengths of ¾ in. and 2 in. (Electronics and Instrumentation Division, Baldwin-Lima-Hamilton Corp., Dept. Sci615, Waltham, Mass.)

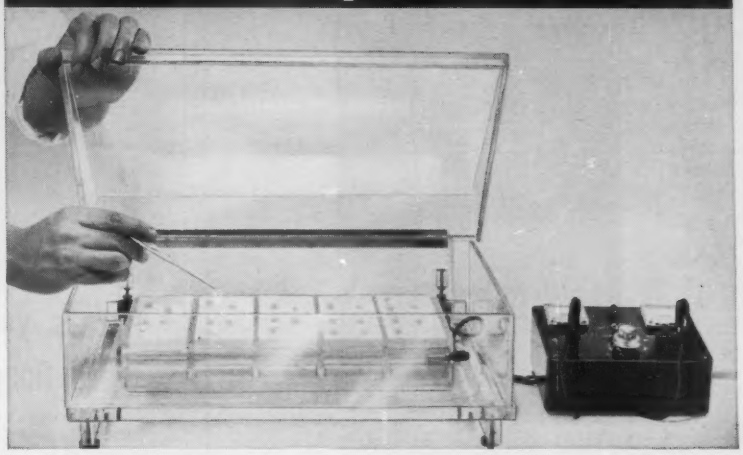
■ KINETIC THEORY APPARATUS is designed to permit demonstration of the fundamental principles of gas mechanics. Plastic balls, ⅛-in. in diameter, are used to simulate molecules. Concentration is varied by varying the number of balls placed in an impeller chamber. Among the experiments that can be performed are: effect of change of temperature on volume and pressure; variation of pressure with volume; measurement of molecular diameter. (Central Scientific Co., Dept. Sci605, 1700 Irving Park Rd., Chicago, Ill.)

■ NULL DETECTOR is a d-c instrument with eight ranges of sensitivity from 10 μv to 100 volts full scale. Input resistance is 10 megohms on all ranges. The input floats above ground by a minimum of 200 megohms. The detector may be used as a d-c amplifier with a gain of 100 db. A hunt mode of operation provides 60 db of meter scale compression to eliminate the need to switch ranges. A calibrate mode covers a linear range −1.2 to +1.2. (Boonton Electronics Corp., Dept. Sci619, 738 Speedwell Ave., Morris Plains, N.J.)

■ PLATINUM-CLAD LABORATORY WARE is said to be capable of resisting temperatures of 1000°F for years of use. Crucibles and evaporating dishes are fabricated of stainless steel 0.033 in. thick, clad on the inside with 0.002-in. thick platinum-rhodium alloy. Edges and pouring spouts are rolled over to prevent contact with contents. Crucibles are 42 mm in diameter by 42 mm deep; dishes are 72 mm in diameter by 33 mm deep. (Fisher Scientific Co., Dept. Sci631, 717 Forbes St., Pittsburgh 19, Pa.)

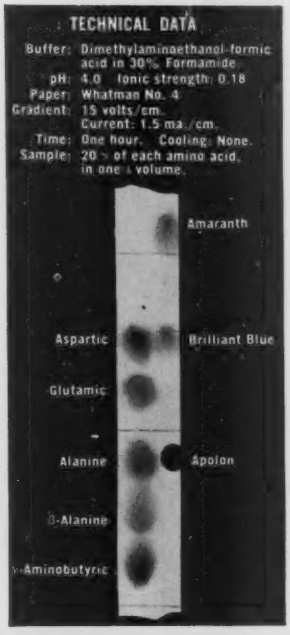
■ DIGITAL TRANSLATOR accepts digital data and provides an analog output and control signals for automatic operation of the manufacturer's *X-Y* recorders. Accuracy of the conversion is said to be ±0.1 percent. The translator accepts four digits and sign each axis and is compatible with I.B.M. summary punches and card readers and may also be driven by punched-tape readers. Ac-

Rapid Paper Electrophoresis



New MISCO Unit Uses Organic Buffers, Completes Separations in 1 Hour

Misco's advanced multiple-cell electrophoretic techniques feature organic buffers for both analytical and clinical investigations. Usually within an hour, unknown compounds can be completely characterized or known samples separated for quantitative analysis. Just as rapidly, this flexible unit will purify up to a few milligrams of any compound that can be separated by electrophoresis.



The Misco apparatus and special organic buffers were developed by Dr. Harold T. Gordon of the University of California. Particular success has been achieved with small organic molecules such as amino acids, carbohydrates and peptides.*

The Gordon-Misco technique offers three key innovations — organic buffers in formamide, a multi-chamber cell, and reference dyes. The buffers minimize evaporation, allow much higher voltages. The multi-chamber cell is designed for running 1 to 5 samples *simultaneously* at 5 different pH values from 3.3 to 9.3. Reference dyes (such as Amaranth and Apolon) assure reproducible relative mobility values, often make possible the calculation of the pK and molecular weight of the unknown.

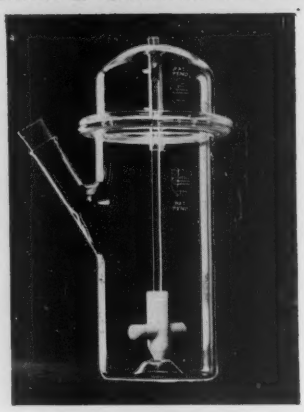
Misco will be happy to send you more information about rapid paper electrophoresis and a reprint of the Werum-Gordon-Thornburg article. Please address Dept. 98.

*Rapid Paper Ionophoresis Using Organic Buffers in Water-Formamide and Water-Urea. L. N. Werum, H. T. Gordon, W. Thornburg. *J. Chromatography* (in press).

MICROCHEMICAL SPECIALTIES CO.
1825 EASTSHORE HIGHWAY BERKELEY 10, CALIFORNIA
Specialists in Micro Techniques for 22 Years

SPINNER FLASKS*

SUSPENDED CELL CULTURE UNIT
for Biochemical & Quantitative Growth Studies



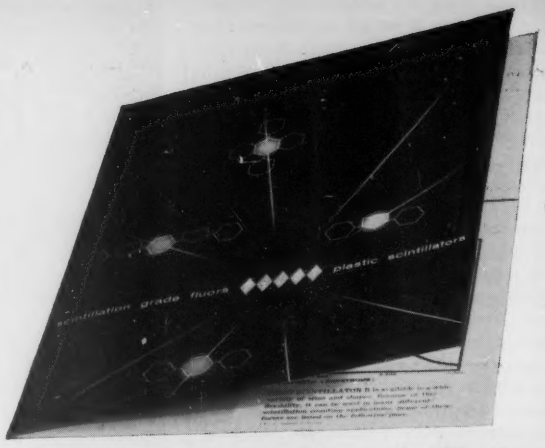
- Standard model offered in 5 sizes, with single or double sidearm.
- Micro and centrifuge types also available.
- Features Teflon impeller assembly.
- Complete unit can be autoclaved.

"research deserves the best"

SEND FOR LEAFLET SF-1

BELLCO GLASS INC.
VINELAND, NEW JERSEY

*PATS. PENDING



Here's your guide to scintillation grade fluors and plastic scintillators

For ten years Pilot Chemicals has been producing high quality fluors and plastic scintillators.

Pilot fluors are the purest available, with maximum light output and high melting point. Pilot plastic scintillators feature highest light output and shortest decay time.

We'd like to send you our Bulletin 591-S, listing our complete line of fluors and describing our plastic scintillators. (Only Pilot makes both!) What's more, we'll gladly send you a sample of PPO, PBD, or POPOP on request for your own test purposes. Just write

PILOT CHEMICALS, INC., 36 Pleasant St., Watertown 72, Mass.

Bird, Continuous Feed

KYMOGRAPH

The outstanding features of modern industrial recorders are retained in this instrument without losing the versatility necessary for kymograph work. Ink writing levers are used exclusively.

The machine feeds an 80 foot roll of paper, 6 inches wide, at any of its eight speeds. Four of these are had with external gears of 40 and 56 teeth in one position, by simply operating a gear-shift knob. By reversing the external gears, four additional speeds become available.

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Manufacturers & Distributors of Scientific Equipment
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REHABILITATION OF THE MENTALLY ILL

Social and Economic Aspects

Social and Economic Sciences and the American Sociological Society.

A symposium of the American Psychiatric Association, cosponsored by the AAAS Section on

Edited by Milton Greenblatt and Benjamin Simon

This volume presents an up-to-date picture of rehabilitation in its broadest sense. The contributions are from outstanding researchers and practitioners in the field. The process of rehabilitation is examined from the standpoint of (*a*) hospital, (*b*) transitional aspects, and (*c*) community. The rehabilitation of the individual in the total sense is seen as a continuum starting from the moment of admission to his final resettlement in the community and many techniques and recommendations for improved patient care and treatment are contained in the book.

December 1959, 260 pp., $5.00
AAAS Members' Cash Orders $4.50

English Agents: Bailey Bros. & Swinfen, Ltd.
Hyde House, West Central Street
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AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
Washington 5, D.C.

1515 Massachusetts Avenue, NW

cessories available include a magnetic-tape reader, a Flexowriter converter, a remote readout panel, and an optical magnetic tape converter. (F. L. Moseley Co., Dept. Sci632, 409 N. Fair Oaks Ave., Pasadena, Calif.)

■ STANDARD LEAK for halogen-type leak detectors is a portable unit that releases refrigerant gas through a capillary tube at manually adjustable rates ranging up to about 3 oz/yr. A circular dial indicates the rate. The device contains sufficient gas for more than a year of normal use and can be refilled. (General Electric Co., Dept. Sci607, Schenectady 5, N.Y.)

■ FILTER ELEMENT CLEANER places an intense ultrasonic field over a small portion of the surface of the filter. The filter element is rotated through the field until the entire surface is cleaned. Particles are flushed away continuously as they are loosened. The operation is said to require less than 10 minutes for most filters. (Pall Corporation, Dept. Sci610, 30 Sea Cliff Ave., Glen Cove, N.Y.)

■ DIFFERENTIAL-TRANSFORMER INDICATOR displays static, slowly varying, and average values on a 10-in. panel meter. A demodulated output, flat to 500 cy/sec, is available for operation of cathode-ray and recording oscillographs. Five ranges extend from ±0.1 to ±0.001 in one model and ±0.01 to ±0.0001 in another. Accuracy is said to be ±1 percent and maximum resolution 5 μin. (Daytronic Corp., Dept. Sci606, 225 S. Jefferson St., Dayton 2, Ohio)

■ THERMOPILE is said to have response time of 0.01 sec. The detector is mounted in a narrow metal tube, 8.5 mm in diameter, fixed to a large metal base. A metal cover, with drying agent, if required, is supplied to protect the window when the thermopile is not in use. (Engis Equipment Co., Dept. Sci629, 431 S. Dearborn St., Chicago 6, Ill.)

■ MULTIRANGE MICROAMMETER manufactured by P. J. Kipp & Zoneñ, Delft, Netherlands, is based on a specially designed light-spot galvanometer that needs no clamping. Ten voltage ranges extend from 0.5 mv to 15 volts full scale and ten current ranges from 2 μa to 50 ma. Input resistance is 500,000 ohm/volt on voltage ranges. Full-scale deflection is 20 cm. Accuracy is said to be better than ±1 percent of full scale, linearity better than ±0.3 percent. Zero is adjustable to any point on the scale. Period ranges from 2.6 to 3.5 sec. (James G. Biddle Co., Dept. Sci636, 1316 Arch St., Philadelphia 7, Pa.)

■ TACKINESS METER is designed to accommodate the range of tackiness normally associated with rubbered fabric or uncured rubber sheet but can be modified to cover other ranges. The instrument is hand operated and portable and does not damage the surface under examination. (Testing Machines Inc., Dept. Sci633, 72 Jericho Turnpike, Mineola, N.Y.)

■ TORQUE WRENCH CALIBRATOR accommodates wrenches with capacities from 20 in.-lb to 2000 ft-lb in four ranges from 1000 in.-lb to 2000 ft-lb full scale. Calibration accuracy is said to be 0.4 percent of full scale. Torque wrenches of the snap-action type are tested automatically with the torque at the breakaway point displayed on a digital counter. (Steel City Testing Machines, Inc., Dept. Sci635, 8817 Lyndon Ave., Detroit 38, Mich.)

■ THERMISTOR for temperature measurement, control, and compensation is supplied sealed into a glass rod. Temperature coefficient of the thermistor is −3.1 percent per °C. Cold resistance at 25°C is 100 ohms. Time constant of the configuration is 25 sec when suspended by its leads in still air at 25°C. (Victory Engineering Corp., Dept. Sci630, Box 373, Union, N.J.)

■ HARDNESS TESTER is designed to make multiple indentations in reactive or heat-sensitive metals at temperatures up to 1600°C and pressures in the order of 10^{-5} mm-Hg. The indenter is a sapphire point on a molybdenum rod loaded by a 2-kg weight. This assembly is mounted on a cross-feed table adjustable from outside the vacuum chamber so that many closely spaced indentations can be made on one or more samples without losing vacuum. Temperature is said to be controlled within ±1°C. Maximum temperature is greater than 2000°C. (Vacuum Specialties Co., Dept. Sci638, 34 Linden St., Somerville 43, Mass.)

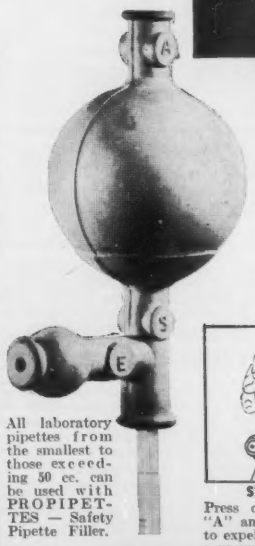
■ SERUM AGAR REACTANTS in agar columns are calibrated to follow changes in concentration and antibody affinity of several serum components in health, disease, and experimental conditions. Reactants may be stored at 4°C. Instrumentation for measurement of precipitin zone movement, density, and patterns is available. (Analytical Products, Dept. Sci609, P.O. Box 6567, San Antonio 9, Texas)

■ VIBRATION TEST SYSTEM features a horizontally moving table supported by air bearings. Systems with 50 lb force output are available with either of

PROPIPETTES
Safety Pipette Filler

The new "PROPIPETTE" eliminates the dangerous practice of using the mouth to draw liquids into pipettes. They are simple to use and the operator quickly becomes proficient so that the liquids can be delivered quickly, precisely and safely. Measurement precision is extremely high—0.01 cc. The instrument has three agate-ball valves which operate independently and the entire procedure can be done entirely with one hand.

APPLICATIONS: Transferring corrosive, toxic, infectious, ill-smelling liquids such as acids, alkalies, cyanides, sulphides, bacteriological cultures, chloroform, ether, urine, blood, excrements, dyes, etc.
Skimming off with precision minute quantities of liquid floating above a sediment without danger of mixing, as in serum from red blood corpuscles and micro-analysis.
Skimming off and measuring the liquid floating above a chemical precipitate.
Transferring sterile samples of liquids to other tubes and containers.
Transferring radioactive solutions.



All laboratory pipettes from the smallest to those exceeding 50 cc. can be used with PROPIPETTES — Safety Pipette Filler.

Easy to Operate

STEP ONE
Press on agate valve "A" and squeeze bulb to expel air and create a vacuum.

STEP TWO
Press on agate valve "S" which draws liquid to the desired level.

STEP THREE
Press on agate valve "E" to expel liquid. To deliver the last drop, cover air inlet in front of "E", press "E" and squeeze the small bulb on the side.

Cat. No. S-77990—Price $6.90 each

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***NEW* ASCO ENCLOSED McLEOD GAUGE**

- Safe—armored—totally enclosed
- Accurate—individually calibrated against standard vacuum gauge
- 3 ranges—700mm Hg. to 1 x 10^{-4}mm. Hg. Range 1—1 to 700mm. Hg.—Range 2—.01 to 1mm. Hg. Range 3—.0001 to .01mm. Hg.
- Direct absolute pressure reading
- May be used to check electronic gauges
- Metal vacuum connection reduces operator hazard
- Rugged O-ring sealed construction
- Reduces expensive breakage
- Dimensions: height 8 9/16", width 6¼", depth 8¼" Face: 5½" x 6½" Weight: 2 pounds

The ASCO ENCLOSED McLEOD GAUGE attains the ultimate goal in design and performance of a tilting-type table model gauge. Accurately calibrated for all permanent gases, the instrument measures three ranges, from 700 mm. Hg. to 1 x 10^{-4} mm. Hg. Simple to operate, the gauge needs only to be rotated to read absolute pressure directly. A low friction mechanical seal between the gauge and connecting tube avoids twisting of tube when gauge is rotated and insures steady positioning when read.

The ASCO McLEOD GAUGE requires approximately 7 cc.'s of mercury, and all glassware is totally enclosed in an attractive case protected by a clear, unbreakable plastic face plate and strong polyester back mounting. Mounted on an all-metal tripod stand, the unit is finished in gray hammertone.

each **$98.00**

accurate...

ACCU-VAC ABSOLUTE VACUUM AND PRESSURE GAUGES

- Precalibrated • Not damaged by vacuum leaks or pressure fluctuation • Light—weighs only 20 ounces
- Black enamelled plastic case

The Accu-Vac gauges combine accuracy, sensitivity, ease of installation and ease of reading in popular ranges of 0-20 mm., 0-40 mm. and 0-760 mm. Hg.

Accu-Vac gauges may be flush-mounted on instrument panels, or directly mounted into the line by use of the threaded coupling or rubber tubing coupling provided with the instrument. The dial face is 4" in diameter, and both graduations and figures are large and accurately readable. Accuracy is 2 parts in 1000, and the gauges are designed for protection against sudden pressure changes within a system, as well as against corrosive gases.

Model	A120	A140	A160
Pressure Range	0-20 mm. Hg.	0-40 mm. Hg.	0-760 mm. Hg.
Each	$94.00	$94.00	$94.00

trouble-free

BATTERY OPERATED THERMOCOUPLE VACUUM GAUGE

- 750 hour battery life
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- 4½" rectangular dial, angle set for easy reading
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- Low temperature thermocouple insures contamination-free readings and continued accuracy
- Long tube life
- No instrument drift
- Instruction provided

Designed for accurate vacuum measurement in the range of 0.5 to 1000 microns Hg. To operate, one simply connects the gauge tube to the vacuum system; no external power source is required. Finished in gray hammertone cabinet with carrying handle.

Complete with gauge tube.....**$104.00**

Replacement tube, each.....**$15.00**

a|s c|o

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two sweep-frequency ranges: 5 cy/ to 5 kcy/sec or 20 cy/ to 20 kcy/sec. Accessory equpiment permits automatic programing of the vibration exciter for specific test requirements. (LCM Engineering, Dept. Sci637, 5005 E. Slauson Ave., Los Angeles 22, Calif.)

■ VACUUM COATER is designed so that the cylindrical vacuum chamber separates at the middle of its height to allow a large area for a variety of feedthrough seals in the lower section. Top and bottom end plates are flat and parallel. The equipment is fabricated of polished stainless steel and is said to be capable of operating at pressures below 10^{-5} mm-Hg. (Vacuum Specialties Co., Dept. Sci639, 34 Linden St., Somerville 43, Mass.)

■ ZONE REFINER for germanium is of multiple-tube horizontal design. From 1 to 12 quartz tubes can be mounted simultaneously. Each tube will accommodate a 30-in. long carbon boat. Traverse speed is continuously variable from 0.8 to 16 in./hr and return speed is variable from 40 to 800 in./hr. (Lindberg Engineering Co., Dept. Sci641, 2450 W. Hubbard St., Chicago 12, Ill.)

■ STRAIN-SENSING ELEMENT is a whisker-sized piezoresistive semiconductor. The whiskers are grown by vapor deposition or are sliced and etched from silicon bars. Ultimate gage factor is said to be 175. Single crystal construction is said to eliminate hysteresis and provide high strength. Operation at temperatures up to 1000°F is said to be possible. (Electro-Optical Systems, Inc., Dept. Sci614, 170 N. Daisy Ave., Pasadena, Calif.)

■ BAROMETRIC-PRESSURE SWITCH is externally adjustable over the altitude range 700 to 25,000 ft. ±10 percent, decreasing. The assembly, which contains a snap-action switch, will withstand vibration of 10 grav at frequencies to 500 cy/sec. Weight is 4 oz and dimensions 2¼ in. in diameter by 2¼ in. long. Switches can be designed for other altitude ranges. (Haydon Switch, Inc., Dept. Sci616, Waterbury 20, Conn.)

■ MEASURING MICROSCOPE scans in two orthogonal directions with ranges 20 and 10 cm. The instrument reads directly to 0.01 mm, and accuracy is said to be ±0.01 mm. Objectives of 5 and 20 magnification are provided. Working distance is 4 cm. Minor adjustment is said to permit placing the instrument directly on the object to be measured. (Ealing Corp., Dept. Sci617, 40 University Rd., Cambridge 38, Mass.)

JOSHUA STERN

National Bureau of Standards, Washington, D.C.

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POSITIONS WANTED

(a) **Biochemist** Ph.D., physiology-physical chemistry minors; Oak Ridge radioisotope technique training; 7 years' experience as analytical biochemist and supervisor; available for research or administrative appointment. (b) **Biologist** Ph.D. zoology M.S. degree; 5 years of university teaching experience; desires animal behavior research or teaching position. (c) **Microbiologist** Ph.D.; mycology-parasitology minors; postdoctoral research on tumor-inhibiting substance; prefers academic or industrial research. S6-3 Medical Bureau, Inc., Science Division, Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

Pharmacologist, Ph.D., 10 years of college teaching; 10 years of industrial pharmaceutical research. Desires academic, industrial, or research position. Box 132, SCIENCE. 6/17

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Anatomy and Physiology for student nurses. Lectures and laboratory supervision. **Biology** for non-science majors. Lectures and laboratory subervision; 12-hour load. Upstate New York private 4-year college affiliated with large university. Woman with doctorate and a knowledge of nursing education preferred. Box 135, SCIENCE. X

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B.S. physical or life sciences to be trained as **Technical Representative** calling upon industrial, hospital, and educational laboratories in assigned territory. Opportunities in the United States and Canada. Salary, bonus, expenses, car, benefits. Laboratory experience preferred but not required. Send full résumé to P. F. Faupel, Fisher Scientific Company, 711 Forbes Avenue, Pittsburgh 19, Pa.

Assistant Parasitologist, male, Ph.D., for survey and life history studies, parasites of man and animals. $7476; 1–3 year grant. Apply Dr. J. E. Alicata, Department of Parasitology, University of Hawaii, Honolulu, Hawaii. X

Biochemist, Ph.D., full-time investigation of fundamental aspects of experimental peritonitis plus independent research. Joint academic appointment. Salary dependent upon professional experience. Department of Surgery, Louisiana State University School of Medicine, New Orleans, La. 6/10, 17

Biochemist or Physiologist for endocrine research laboratory, M.S. or B.S. plus several years' experience in hospital and/or medical research laboratory preferred. Responsible position, excellent salary, and opportunity to work toward higher degree. Apply Personnel Office, Indiana University Medical Center, 1100 West Michigan, Indianapolis. 6/24; 7/1, 8

POSITIONS OPEN

BLOOD GROUP IMMUNOLOGIST

M.S. in field of immunology with good knowledge of protein chemistry & immunohematology to work in manufacturing, performing a liaison function with research. Broad knowledge of antigen-antibody reactions with reference to blood group serology required.
Send resume to:
ORTHO PHARMACEUTICAL CORPORATION
Route 202 **Raritan, N.J.**

ANALYTICAL CHEMIST (B.S.)

To be a member of project group designing and developing analytical laboratory instruments involving potentiometric, colorimetric, and amperometric titrations, photometry, etc.; 2 to 5 years' instrumental analysis experience, including problem solving and laboratory gadgeteering. Send full résumé to P. F. Faupel, Fisher Scientific Company, 711 Forbes Avenue, Pittsburgh 19, Pa.

BIOCHEMIST

Ph.D.—to develop processes for preparation of radioactive labeled compounds using biological synthesis techniques. Opportunity to participate in growth of country's outstanding radiochemical manufacturing company.

NEW ENGLAND NUCLEAR CORP.
575 Albany Street, Boston, Mass.

EXPERIMENTAL BIOLOGIST

Ph.D. or equivalent to work in experimental pathology department. Knowledge of microscopic anatomy and experimental therapeutics desirable. Research opportunity. Staff addition. Industrial pharmaceutical research. Northeastern United States.

Box 129, SCIENCE

(a) **Pharmacologist**; M.D., to serve as regional medical director, midwestern office, prominent pharmaceutical company; liaison, advisory, clinical investigation, related responsibilities; to $17,000 or better. (b) **Biochemist**; Ph.D., experienced clinical biochemistry to head department, 300-bed, fully approved general hospital; $10,000; California. (c) **Bacteriologist**; M.S., Ph.D., to head active department, 300-bed general hospital; large midwestern college city. (d) **Microbiologist**; Ph.D. familiar single, suspended, monolayer cell techniques to head cell production facility, conduct cell culture research for prominent midwestern company; city 75,000. (e) **Medical Director**; proprietary, cosmetics division of noted eastern company; liaison, research responsibilities; substantial salary. (Please write for an analysis form. Our 64th year: Founders of the counselling service to the medical profession; serving medicine with distinction over half a century.) Science Division, Woodward Medical Bureau, Ann Woodward, Director, 185 North Wabash, Chicago. X

Important Notice

Effective 1 September 1960

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No cash discount

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Frequency rate will appiy only to repeat of same ad. No copy changes.

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Histologist-Histochemist, Ph.D. or equivalent. Research institute, New York. Modern well-equipped and staffed air-conditioned laboratory. Opportunity for training in electron microscopy. Address replies to Box 137, SCIENCE. 6/24; 7/1, 8

LABORATORY TECHNICIAN

Major Philadelphia drug firm has opening in its microbiology section for a person with 2 years' college-chemistry course background. Cannot consider college grads. Work in connection with interesting research and development projects in tissue culture-virology area. Interest and experience in biochemical-analytical techniques important (Warburg, U.V. spectrophotometer, chromatography, etc.). Good starting salary. Liberal benefit program includes educational assistance, hospitalization and 35-hour week. Send complete resume including age, work experience and salary needs. Box 138, SCIENCE.

Manufacturers Representatives for complete line of animal cage and laboratory glassware washing machines. Write to E. D. Cowles, Metalwash Machinery Corporation, 901 North Avenue, Elizabeth, N.J. 6/17; 7/1

Medical Technologist, blood banking background desirable. Interest in research required. Excellent opportunity to participate in blood group research. Salary open. Mail replies to R. F. Ambelang, Milwaukee Blood Center, Inc., Milwaukee, Wis. ew

(a) **Microbiology Section Chief** to become assistant director of laboratory division and be groomed for director of division position; start $7300–$9000 year; midwestern health department. (b) **Biochemist,** Ph.D. or M.S., with hospital experience for teaching and research with large medical school hospital; faculty appointment; $6000–$10,000 year; East. (c) **Senior Scientist,** Ph.D. in biochemistry, experienced in protein fractionation techniques and supervising duties with large manufacturer; $8000–$10,000 year; East. (d) **Physiology Sabbatical Appointments**; visiting professor, $10,000 for 9 months; lecturer in mammalian-cellular physiology, $7000–$8000 for 9 months; state university; Midwest. (e) **Immunologist,** Ph.D. degree, interested in research; desirable location; East. (f) **Biochemist,** Ph.D. or M.S. degree, for cancer research institute with university affiliation; East. (g) **Biology Assistant or Associate Professor** for liberal arts college; $6000–$6800; South. (h) **Assistant Bacteriologist** for hospital expanding from 400 to 700 beds; Southwest. (i) **Clinical Biochemist,** Ph.D., microbiology experience desirable; for pathology group serving hospitals and laboratories in area; $9000–$12,000 year; California. (Please write for details; also many other positions available through our nationwide service.) S6-3 Medical Bureau, Inc., Science Division, Burneice Larson, President, 900 North Michigan Avenue, Chicago. X

Proceedings of two conferences by
NAS–NRC Committee on Photobiology

PHOTOPERIODISM AND RELATED PHENOMENA IN PLANTS AND ANIMALS

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$12.50 cash orders from AAAS members

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Washington 5, D.C.

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Single insertion	$40.00 per inch
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7 times in 1 year	36.00 per inch
13 times in 1 year	34.00 per inch
26 times in 1 year	34.00 per inch
52 times in 1 year	32.00 per inch

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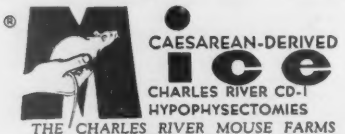
SUPPLIES AND EQUIPMENT



CAESAREAN-DERIVED
Mice
CHARLES RIVER CD-1
HYPOPHYSECTOMIES

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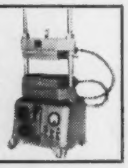

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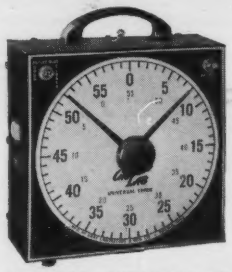

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